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CAA-SR-91-11

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EUROPEAN TRANSPORTATION REQUIREMENTS FOR THE BACKHAUL OF PERSONNEL/CARGO (ETRANS) STUDY

SEPTEMBER 1991

CONCEPTS ANALYSIS AGENCY
UNITED STATES ARMY

PREPARED BY
FORCE SYSTEMS DIRECTORATE

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This transportation study compares the retrograde (backhaul) requirements for two CAA studies focusing on the North Atlantic Treaty Organization (NATO) Central Region. One study is set in 1996 based on a NATO versus Warsaw Pact scenario. The other scenario is based on a post-Conventional Forces in Europe (CFE) environment. Passenger and cargo retrograde transportation mission requirements are identified, estimated, and planned for movement using US and host nation transportation truck companies. Emphasis is placed on anticipated requirements for heavy equipment transporters.

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September 1991

Statement A per telecon
Maj. Joesph P. Brown CAA/CSCA-FSL
Bethesda, MD 20814-2797
NWW 2/28/92

Prepared by

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PROLOGUE

The ETRANS Study was initiated prior to the disintegration of the Soviet Union. Therefore, the scenarios used may not accurately reflect current conditions or other theaters where US forces may be employed. However, the analysis of retrograde transportation included in this study can be adjusted to changing conditions in Europe and to scenarios in other theaters.

Force planners should evaluate the need for retrograde transport for each of the topics addressed in Chapter 2. Particular attention should be given to the three topics of highest retrograde transport consumption: unit moves (paragraph 2-9), supply and ammunition stocks (paragraph 2-10), and maintenance evacuation (Chapter 5). The planner must evaluate the factors present in the theater that have a beneficial or adverse effect on rearward movement of passengers and cargo. The factors may be similar to those listed in Chapter 7. A method of integrating forward and rearward transport requirements can be adapted from the discussion in Chapter 4. The development of a planning factor as demonstrated in Chapter 8 can then follow.

If computerized support for force modeling is available to theater battle planners, they must make sure that the model explicitly includes or excludes the high users of retrograde transport as a workload factor. As noted in paragraph 3-10, CAA models contain workloads to represent units moving from the ports of debarkation to the initial staging area, but subsequent (battlefield) unit move workloads are not captured. However, CAA could alter transportation force structure determination in the support requirements model if given the factors by which retrograde workload is anticipated to change total transport requirements.

Assets for the heavy truck missions should be adapted to the missions envisioned in the field. The spreadsheet methodology in Appendix F can be used for estimating the number of heavy truck companies needed for maintenance evacuation. The maintenance values for tracked vehicles not provided in Appendix E can be estimated and adjusted to best reflect the conditions found in the area of operations. The concepts presented in paragraph 2-13 may aid in estimating the degree that heavy trucks will be needed in assisting unit moves.

Finally, the analytical approaches discussed in this report could be used to aid in planning for LOGCAP or host nation support requirements. They could also be helpful in developing risk analysis for force decrements or requirements shortfalls.

DEPARTMENT OF THE ARMY
US ARMY CONCEPTS ANALYSIS AGENCY
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REPLY TO
ATTENTION OF:

CSCA-FSL/P (5-5d) 27 JAN 1992

MEMORANDUM FOR Deputy Chief of Staff for Logistics,
ATTN: DALO-PLP, Washington, DC 20310-0544.

SUBJECT: European Transportation Requirements for Backhaul of Personnel/Cargo

1. Reference memorandum, DALO-PLA, HQDA, 21 September 1991, subject: European Transportation Requirements for Backhaul of Personnel/Cargo - Study Directive.

2. Referenced memorandum requested that the U.S. Army Concepts Analysis Agency quantitatively determine whether assets planned for wartime transportation of personnel/cargo forward to the combat zone are sufficient to also satisfy the anticipated retrograde requirements.

3. This final report documents the results of our analyses and incorporates your comments on the draft report which were received in December 1991. Included is an executive summary which provides an overview of the entire study, and a one-page prologue which discusses possible application of the study methodology outside the European theater. Questions and/or inquiries should be directed to the Assistant Director, Force Systems Directorate, U.S. Army Concepts Analysis Agency, 8120 Woodmont Avenue, Bethesda, MD 20814-2797, DSN 295-1607.

4. I would like to express my appreciation to the many commands, schools and agencies which have contributed to the study. Special thanks go to the U.S. Army Materiel Systems Analysis Agency and the U.S. Army Transportation School for their effort and expertise.

Philip E. Louer
for E. B. VANDIVER III
Director

CAA	EUROPEAN TRANSPORTATION REQUIREMENTS FOR THE BACKHAUL OF PERSONNEL/CARGO (ETRANS) STUDY	STUDY SUMMARY CAA-SR-91-11

THE REASON FOR PERFORMING THE STUDY was to determine if the logistics movement of personnel/cargo away from the forward edge of the battle area (FEBA) is a significant transportation workload. If significant, how should it be incorporated into theater force structure determination.

THE STUDY SPONSOR was the Deputy Chief of Staff for Logistics (DCSLOG), Headquarters, Department of the Army (HQDA).

THE STUDY OBJECTIVE was to determine the effect of retrograde transportation requirements on the total force structure and to determine if a "retrograde transportation force structure planning factor" can be developed.

THE SCOPE OF THE STUDY was to use the results of two significantly different wartime analysis studies performed by US Army Concepts Analysis Agency (CAA). The first, Programmed Force Capabilities Analysis Europe-96 (PFCAE-96), is the traditional scenario of global conventional war with the Warsaw Pact; no chemical or nuclear warfare. The second, Program Force Alternative Scenario Study (PFASS), models the post-Conventional Forces in Europe (CFE) battlefield.

THE MAIN ASSUMPTIONS of this work were:

(1) Data from the Army Force Planning Data and Assumptions (AFPDA) are appropriate for this analysis.

(2) Host nation support will be available as bilaterally agreed.

(3) The use of transportation modes consistent with United States Army, Europe (USAREUR) theater policy is appropriate for this analysis.

(4) Retrograde (backhaul) movements begin on D-day.

THE BASIC APPROACH was to consider all retrograde (backhaul) missions and compare the results for the two scenarios. Total mission requirements were estimated, the mission requirements were analyzed from a transportation viewpoint, and transportation resources were allocated by truck type and nationality for mission execution.

THE PRINCIPAL FINDINGS of this study are:

(1) Daily passenger (PAX) for retrograde movement averaged 9,218 for PFCAE-96 and 4,507 for PFASS in addition to noncombatant evacuation operations. Daily retrograde cargo in short tons (STON) averaged 41,186 for PFCAE-96 and 16,971 for PFASS. Daily rearward movements by heavy equipment transporter (HET) of combat vehicles averaged 396 for PFCAE-96 and 222 for PFASS in addition to the commander's requirement for tactical relocation HET support.

(2) To execute the tracked vehicle maintenance evacuation mission, PFCAE-96 required between 6 and 8 heavy truck companies (24 HETs per company) available at the beginning of the war depending on the degree of risk to be assumed. PFASS required three companies. Other missions for heavy trucks are tactical relocation and aiding the relocation of maintenance units working on tracked vehicles.

(3) The net total US force structure additions required are five medium and three heavy truck companies for the PFCAE-96 scenario and two medium and two heavy truck companies for PFASS. These are minimum US additions and exclusive of force structure that can be reasonably provided by the host nation.

(4) Dislocation of the FEBA is the overwhelming influence on the need for additions to overall transportation force structure, including US force structure additions. Combat support/combat service support (CS/CSS) unit movement requirements comprise the greatest single part of the addition. The current force structuring process does not compute common-user transportation requirements for any unit moves after initial battlefield deployment. Other operational factors affecting force structure additions are the degree of peacetime preparation for war, warning time prior to movement, host nation support, and air superiority.

(5) Light trucks used for retrograde are almost exclusively in support of noncombatant evacuation order (NEO): a planning factor of .92 light truck companies per 100,000 NEO participants is reasonable for the Central Region. Host nation buses are preferred for this mission. Planning factors for medium trucks are a population constant of .83 medium truck companies per 100,000 theater population and a FEBA displacement factor of .297 medium truck companies times the average rate of FEBA displacement in kilometers per day. Heavy trucks are used in proportion to the intensity of the battle and the desires of the commander. No general planning factor could be determined for heavy trucks.

COMMENTS AND QUESTIONS may be sent to the Director, US Army Concepts Analysis Agency, ATTN: CSCA-FSL, 8120 Woodmont Avenue, Bethesda, Maryland 20814-2797

Tear-out copies of this synopsis are at the back cover.

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CHAPTER 1

EXECUTIVE SUMMARY

1-1. PROBLEM. It is unknown whether logistics movement of personnel/cargo away from the forward edge of battle area (FEBA) is a significant transportation workload. If significant, how should it be incorporated into theater force structure determination?

1-2. BACKGROUND. The prevalent response to questions regarding the need for assets for retrograde transportation for movement away from the battle area has been that there would be sufficient empty resources returning from forward areas to accommodate all such rearward movement requirements. Two recent US Army Concepts Analysis Agency (CAA) studies examined this question in some detail. The first, Wartime Retrograde of Damaged Materiel from a Theater of Operations (RETRO) conducted a literature search for Army doctrine and discussed some considerations for modeling rearward movements. The second study, Retrograde Transportation II (RETRO II), provided the theoretical logic for the calculation of personnel, general cargo, and end items needing transport away from the forward areas during the course of a conflict in the North Atlantic Treaty Organization (NATO) Central Region. This logic was designed to be compatible with that of the Army's support force structuring model, Force Analysis Simulation of Theater Administrative and Logistic Support (FASTALS). This study builds on the RETRO and RETRO II Studies and provides a quantitative analysis.

1-3. OBJECTIVES

a. To determine the effect of retrograde transportation requirements on the total force structure.

b. To determine if a "retrograde transportation force structure planning factor" can be developed.

1-4. SCOPE. The study used the results of two significantly different wartime analyses. The first, Programmed Force Capabilities Analysis Europe-96 (PFCAE-96), is the traditional scenario of global conventional war with the Warsaw Pact; no chemical or nuclear warfare. The second, Program Force Alternative Scenario Study (PFASS), models the post-Conventional Forces in Europe (CFE) battlefield. Logistics support required from D-day to D+90 for each scenario was examined.

1-5. LIMITATION. Data for analysis came from, or was derived from, existing sources. Not all data supplied by the US Army Training and Doctrine Command (TRADOC) community was formally approved.

1-6. TIMEFRAME. 1996 (PFCAE-96) and post-CFE (PFASS).

1-7. KEY ASSUMPTIONS

a. Data from the Army Force Planning Data and Assumptions (AFPDA) are appropriate for this analysis.

b. Host nation support (HNS) will be available as bilaterally agreed.

c. The use of transportation modes consistent with United States Army, Europe (USAREUR) theater policy is appropriate for this analysis.

d. Retrograde (backhaul) movements begin on D-day.

1-8. STUDY APPROACH AND METHODOLOGY. All retrograde (backhaul) missions were considered, and the results for the two scenarios were compared. Total mission requirements were estimated, the mission requirements were analyzed from a transportation viewpoint, and transportation resources were allocated by truck type and nationality for mission execution.

a. Figure 1-1 provides a schematic of the overall methodology for this study. The RETRO and RETRO II Studies provided the basis for the process of estimating requirements. The concept of comparing two dissimilar scenarios was developed as a result of the political events in the Soviet Union and negotiations between the Warsaw Pact and NATO to reduce conventional forces. The PFASS scenario was constructed by CAA to estimate the effects of the CFE Treaty and was not intended to replace the officially approved scenario that PFCAE-96 represented.

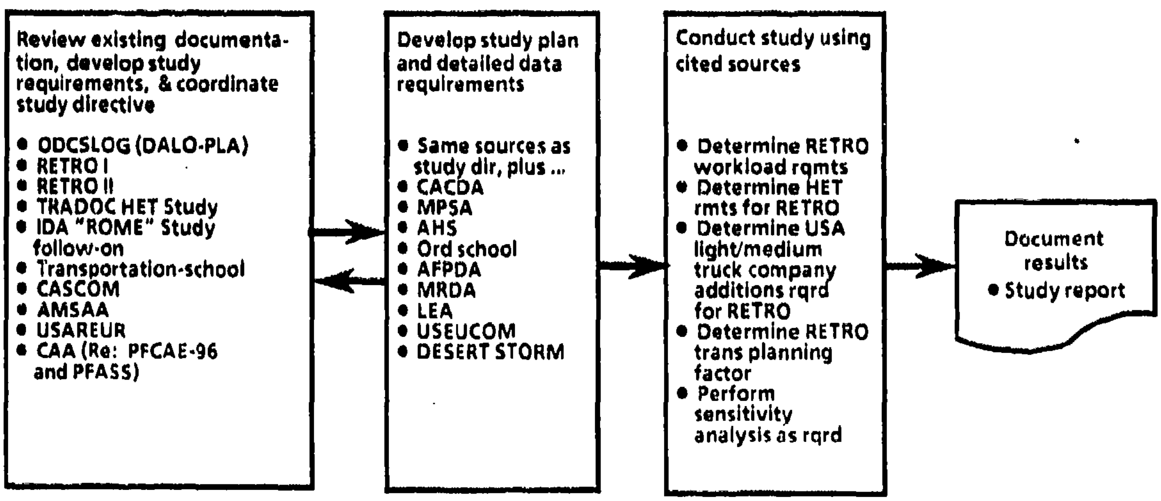

Figure 1-1. Study Methodology - Overview

b. Figure 1-2 illustrates the procedures contained in the third block of Figure 1-1 and shows the sequential nature of the answers to the EEA and their location by chapter. The scenario comparison was facilitated by having each scenario processed by both the CEM and FASTALS Models. The computer output format was identical for both scenarios.

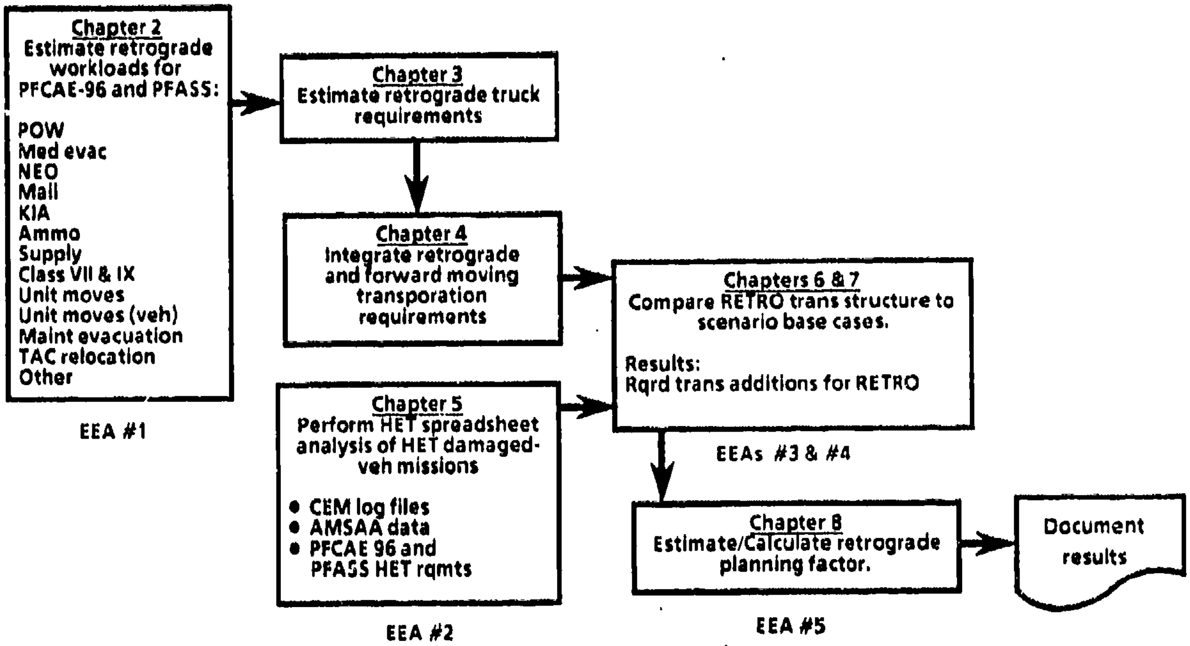

Figure 1-2. Methodology: Study Execution

1-9. ANSWERS TO ESSENTIAL ELEMENTS OF ANALYSIS

a. What is the total US retrograde requirement (number of personnel, tons, etc.) for the NATO Central Region?

ANSWER: Daily passenger (PAX) for retrograde movement averaged 9,218 for PFCAE-96 and 4,507 for PFASS in addition to noncombatant evacuation operations. Daily retrograde cargo in short tons (STON) averaged 41,186 for PFCAE-96 and 16,971 for PFASS. Daily movements by heavy equipment transporter (HET) of combat vehicles averaged 396 for PFCAE-96 and 222 for PFASS in addition to the commander's requirement for tactical relocation.

b. What portion of the heavy truck companies currently in the force structure exist as a result of requirements to evacuate damaged vehicles?

ANSWER: To execute the tracked vehicle maintenance evacuation mission, PFCAE-96 should have between 6 and 8 heavy truck companies (24 HETs each) available at the beginning of the war. PFASS should have three companies. Other missions for heavy trucks are tactical relocation and aiding the relocation of maintenance units working on tracked vehicles.

c. What additions, if any, to US wartime transportation force structure are necessary to execute retrograde requirements?

ANSWER: US force structure additions are five medium and three heavy truck companies for the PFCAE-96 scenario and two medium and two heavy truck companies for PFASS. These are minimum US additions and exclusive of force structure that can be reasonably provided by the host nation.

d. If additions to transportation force structure are needed to support retrograde missions, what are the factors that affect the quantification of these additions?

ANSWER: Dislocation of the FEBA is the overwhelming influence on the need for additions to overall transportation force structure, including US force structure additions. Combat support/combat service support (CS/CSS) unit movement requirements comprise the greatest single part of the addition. The current force structuring process does not compute common-user transportation requirements for any unit moves after initial battlefield deployment. Other operational factors affecting force structure additions are the degree of peacetime preparation for war, warning time prior to movement, host nation support, and air superiority.

e. If the study results can be extended to support it, what is the value, or range of values, for a "retrograde transportation force structure planning factor" useful for general planning?

ANSWER: Light trucks used for retrograde are almost exclusively in support of noncombatant evacuation order (NEO) operations: .92 light truck companies per 100,000 NEO participants is reasonable for the Central Region. Host nation buses are preferred for this mission. A retrograde mission planning factor for medium trucks includes a population constant of .83 medium truck companies per 100,000 theater population and a FEBA displacement factor of .297 medium truck companies per 100,000 soldiers times the average rate of FEBA displacement in kilometers per day. Heavy trucks are used in proportion to the intensity of the battle and the desires of the commander. No general planning factor could be determined for heavy trucks.

1-10. OTHER KEY FINDINGS

a. The current use of "nonmobile weight," a term used in TOE documents, is not representative of the total weight that needs transport on the battlefield.

b. Retrograde transportation is a critical component of a commander's battle plan. The relationship of transportation resources to retrograde requirements has not been studied in sufficient detail.

c. Movement of units on the battlefield is the single most important and resource-intensive element of retrograde transportation. Doctrine is needed to address this widely recognized, but neglected, military reality.

d. An analysis of FASTALS Workload 18 (Dry Cargo and Unit Equipment by Truck) output indicates that the proportion of Class V moving forward is approximately 20 percent and occurs in all portions of the theater. When supplies are moved rearward, the proportion of Class V is approximately 80 percent and occurs in the division and corps areas. As transport of Class V has unique requirements, study is needed to ensure that the proper procedures can be followed.

e. The primary mission of HETs is to bring operable systems forward to battle. However, the secondary mission, maintenance evacuation, overwhelms the primary mission to the degree that virtually the entire primary mission is performed if the secondary mission is done.

f. More than 95 percent of the HET mission occurs in the division area. However, all heavy truck companies are assigned to the corps or theater.

g. Comparison of the two widely disparate scenarios indicates the distinct value of anticipating the relative course of the war. Requirements for medium truck companies varied widely.

h. When workloaded to standard transportation factors, the current (FASTALS) force structure process seems to generate an excess of capability in response to the patient workload.

i. The force structure provisions for handling mail in the Central Region do not conform with expected policies for security and other operational considerations.

j. Additional study is needed to determine the degree of HET support needed for the relocation of maintenance units to establish a valid estimate of the potential requirement.

CHAPTER 2

RETROGRADE ESTIMATES FOR PERSONNEL/CARGO

2-1. PURPOSE. To estimate the number of personnel and the amount of cargo that will need retrograde transportation in the NATO Central Region for the first 90 days of combat.

2-2. INTRODUCTION. This study addresses only logistics issues concerned with the retrograde (rearward) movement of personnel and cargo; not tactical maneuvers such as withdrawal or retirement. Retrograde portions of logistic operations are a normal and expected activity during the course of all battles and are not necessarily indicative of tactical success or failure. Not all the topics associated with retrograde transportation have been studied in detail; therefore, its burden on the logistics system is unknown. Responsibility for execution of retrograde movement and assignment of assets are often not included in war plans for the Central Region and are not explicitly included in CAA logistic modeling.

a. The primary tool used by CAA to estimate the combat service and combat service support force structure needed to support combatants is the FASTALS Model.

(1) The model is a valuable aid for several portions of the ETRANS analysis. A description of the model and detailed discussion of several topics germain to this study are contained in Appendix H. However, FASTALS reflects the conscious decisions of force structure experts and Army doctrine. Retrograde transportation is not a topic that is specifically and directly included in the program. Indirect uses of FASTALS data, to support ETRANS analysis, are included throughout the study.

(2) Large-scale computer programs such as FASTALS are not designed to achieve the required resolution to answer specific questions that arise during a study such as ETRANS. Sources and techniques aside fom FASTALS for arriving at retrograde requirements will be explained.

b. This chapter discusses the various components of retrograde movement to include estimates of the quantity of movement for 10-day time periods (TP) by FASTALS logical region (LR) for each of two CAA scenarios. The LRs are defined as LR1 = division area, LR2 = corps area, LR3 = rear combat zone (RCZ), LR4 = communications zone (COMMZ), and LR5 = seaports and airports. Both scenarios are capabilities-oriented; that is, they predict the expected performance of a given combat force.

(1) The first scenario, the Programmed Force Capabilities Assessment, Europe-96 (PFCAE-96) Study, is the traditional cold war scenario focusing on the NATO Central Region. Some PFCAE-96 units are at full strength, but others have shortages reflective of anticipated Army shortages. NATO forces in the Central Region are withdrawing for the duration of the campaign.

(2) The second is the Program Force Alternative Scenario Study (PFASS) which is illustrative of forecasted US force strength in the post-CFE treaty environment. Several aspects of this scenario are different from PFCAE-96:

the unified German border is more easterly, fewer US forces are forward-stationed, warning time has increased, and the battle is fought with roughly equivalent opposing forces. The FEBA moves more slowly and is relatively static compared to PFCAE-96.

c. Subsequent chapters analyze the transportation requirements developed in this chapter for each scenario in terms of the need for US tactical truck companies or host nation rail and truck support. Although the scenarios are capabilities-oriented, the transportation solutions will be requirements oriented, that is, the number of assets that are needed to accommodate the entire requirement.

d. Data arranged in tables for PFCAE-96 and PFASS are entered as pairs with the PFCAE-96 figure appearing above and to the right of the PFASS number; for example, the data pair $_{0}13$ indicates the PFCAE-96 value is 13 and the PFASS value is 0.

e. The most common method to aggregate workloads is a simple average for TP3-11. Where other methods are employed, they will be explicitly explained. An average workload figure is likely to conform more favorably to PFASS workload values than to PFCAE-96 values.

2-3. RETROGRADE MISSIONS. Each retrograde mission included in this chapter states the origin of the data used, adjusts the data if needed, and provides an estimate to determine the total mission requirement. A summary table of requirements appears at the end of the chapter. Table 2-1 is a list of the missions as set forth in the RETRO II Study. Each is identified with the truck types most associated with mission execution. **NOTE:** this study is concerned with transportation truck units. For study purposes, trucks in a light truck company are termed light trucks, those in a medium truck company are called medium trucks, and HETs are in a heavy truck company.

Table 2-1. Retrograde Missions

Paragraph	Mission	Transportation truck company
2-4	Enemy Prisoners of War (EPW)	Light
2-5	Medical Evacuation	Light
2-6	Noncombatant Evacuation Order (NEO)	Light
2-7	Killed in Action (KIA)	Light/Medium
2-8	Mail	Light/Medium
2-9	Unit Moves (except tracked vehicles)	Medium
2-10	Supply and Ammunition Stocks	Medium
2-11	Class VII and IX Parts	Medium
2-12	Maintenance Evacuation (tracked vehicles)	Heavy
2-13	Unit Moves (tracked vehicles)	Heavy
2-14	Tactical Relocation (tracked vehicles)	Heavy
2-15	Captured Enemy Materiel	All
2-15	Denial Operations	All
2-15	Strategic Materials	All

2-4. ENEMY PRISONERS OF WAR (EPW). The capture and handling of EPW according to the Geneva Convention can be expected along the FEBA for the duration of the war. The modeling of EPW movement is specifically included in CAA modeling and identified as FASTALS Workload #15. The model provides for EPW capture only in the division area.

a. Data Collection. FASTALS operation provides for accumulating estimated EPWs starting during TP2 and continuing through TP11. There are no EPW workloads shown for LRs 3 and 5 because EPWs are normally evacuated directly from the corps to the detention centers in LR4 or flown out of the theater aerial ports of embarkation (APOE) to the continental United States (CONUS). Table 2-2 displays the number of EPWs/day by LR for TP2-11 for both scenarios.

b. Data Adjustments. The FASTALS values for LR1 in Table 2-2 do not directly translate into transportation requirements. Some EPWs are carried over to the next TP as shown in Figure 2-1, but no carryover exists in LRs 2 and 4. Similar EPW flow continues for TP7-11 and also for PFASS. Figure 2-1 indicates that EPWs captured during TP2 (pre-D-day) and TP3 do not arrive at LR4 until TP5. Ultimately, EPWs are expected to be evacuated to CONUS or other overseas locations. Such movement is likely not to occur until all US noncombatants and casualties available for air movement have departed the Central Region.

Table 2-2. Location of EPW/Day (PFASS\PFCAE-96)

LR	TP 2	3	4	5	6	7	8	9	10	11
1	13	65	89	108	112	82	84	57	23	19
	0	29	77	81	86	103	105	100	108	104
2	0	0	45	60	75	105	60	75	45	15
	0	0	15	60	60	60	75	75	60	75
4	0	0	0	45	60	75	105	60	75	45
	0	0	0	15	60	60	60	75	75	60

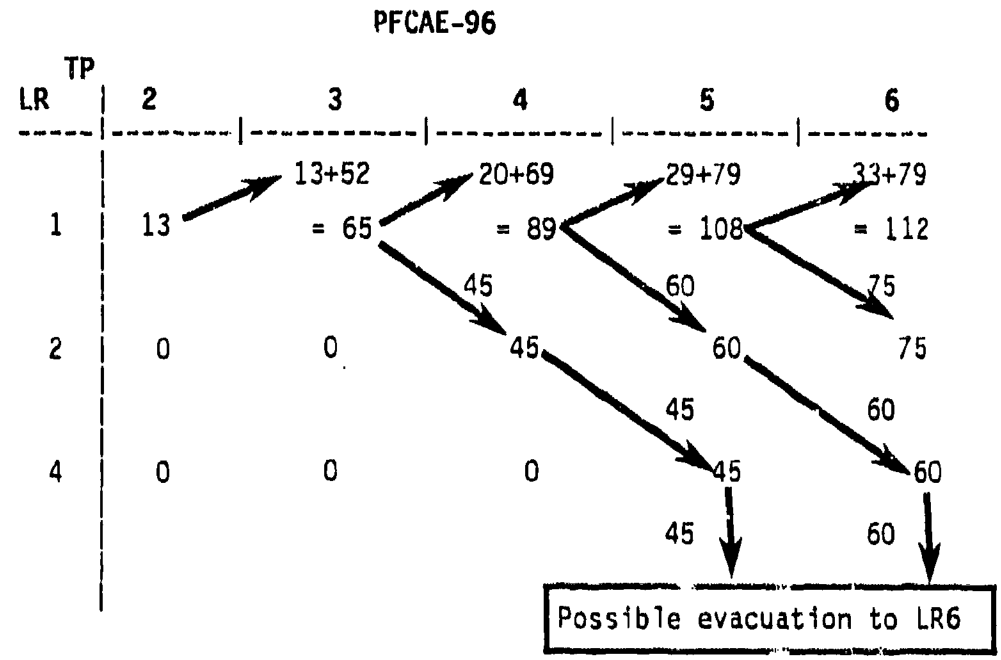

Figure 2-1. Daily Flow of EPW between Logical Regions

c. **Estimate.** The total transportation workload for each region is derived by extending the flow diagram for PFCAE-96 and PFASS EPW data as shown in Table 2-3. Totaling the TP figures and dividing by the number of TPs having data entries provides the average EPW requirements for movement of EPWs for each LR.

Table 2-3. Retrograde Workload for EPWs (PFASS\PFCAE-96)

Time period	Within division	Division to corps	Corps to theater	Theater to APOD	Total
3	52 29				52 29
4	69 63	45 15			114 78
5	79 64	60 60	45 15	45 15	229 154
6	79 65	75 60	60 60	60 60	274 245
7	75 77	105 60	75 60	75 60	330 257
8	62 77	60 75	75 60	75 60	272 272
9	48 70	75 75	60 75	60 75	243 295
10	10 68	45 60	75 75	75 75	205 278
11	11 71	15 75	45 60	45 60	116 266
Average workload	485/9=53.9 584/9=64.9	480/8=60 480/8=60	435/7=62.1 405/7=57.8	435/7=62.1 405/7=57.8	

2-5. MEDICAL EVACUATION. Two subjects for retrograde analysis are included in this topic. First, individual rearward movement of wounded, injured, and sick patients or transfer between hospitals based on the care required. Second, the wholesale movement of patients due to the relocation of the hospital facility.

a. Routine Evacuation. The number of patients moved routinely based on medical care requirements is simulated by the Patient Flow Model (PFM). The PFM is based on FASTALS Workload #1, US Army Population, that counts the total troop strength in each LR. Since the PFM factors in LR1 are based only on combatant strength, Workload #22 (US Army Nondivisional Population) is used to adjust the population in LR1 downward to reflect the estimated number of combatants. The logic of the model from a transportation viewpoint is described in detail in Chapter 6 of the RETRO II Study.

b. **Patient Flow.** Table 2-4 provides the results of the PFM for PFCAE-96 and PFASS. The PFCAE-96 patient flow for TP 9-11 is abnormally low because the Concepts Evaluation Model (CEM) provided results for only the first 60 days of combat. The PFM reflects only noncombat activity thereafter.

Table 2-4. Patient Flow (PFASS\PFCAE-96)

Time period	LR1 to LR2	LR2 to LR 4	LR4 to APOE
3	22,780 9,678	14,781 5,636	6,896 2,439
4	35,370 17,243	27,682 12,672	20,845 8,909
5	44,712 15,948	37,128 13,863	30,345 12,870
6	39,197 17,807	35,913 14,455	26,381 9,362
7	28,814 20,629	27,724 16,474	21,815 10,166
8	16,789 20,090	17,322 18,101	14,926 11,415
9	6,099* 20,266	7,234* 17,316	4,544* 7,320
10	5,821* 19,184	4,119* 16,108	1,133* 6,614
11	5,484* 19,736	3,820* 16,159	943* 6,365
Average (TP3-8) workload (TP3-11)	31,277 17,843	26,758 14,532	20,235 8,384

*Not included in average workload calculation.

c. **Hospital Evacuation.** The second population of patients to move occurs when the hospitals in LRs 2 and 4 need to be relocated because the FEBA is moving rearward.

(1) This phenomenon is highlighted in PFCAE-96 as the FEBA moves 644 km (7.2 km/day average) in the 90-day war. All hospitals in the Central Region are affected.

(a) Several methods can be used to analyze hospital evacuation. The logic of how the study treated the movement of hospitals is identical to the logic for the movement of any other unit and is explained in Appendix G, Unit Moves. In this case, Manpower Requirements Criteria (MARC) values indicate that hospitals are expected to move every 29 days after initial employment. To prevent working with fractions of hospitals spread between TP5 and 6, for study purposes, assume the first move starts on day 30 so that no relocations occur in TP3-5. The hospitals begin to move in TP6 and continue to move for the remainder of the simulation period.

(b) The 29 days between hospital relocations would appear to be more lenient than an analysis of FASTALS for PFCAE-96 physical regions would imply. Some of the combat support hospitals for PFCAE-96 would have to move within the first 20 days as corps physical regions become occupied by division forces.

(c) A third method of analysis based on geographical considerations could determine that LR2 is an average of 100 km deep. Under these circumstances, corps support and LR4 hospitals would have to move every 14 days (100 km/7.2 km FEBA loss rate/day = 14.3 days) based on the PFCAE-96 average FEBA movement rate.

(2) Since the PFASS FEBA displaces its maximum of 18.9 km to the rear of its original line during TP8, ETRANS allowed only 50 percent of the hospitals in LR2 and none of the hospitals in LR4 to move through TP8, the presumption being that the need to relocate rearward is reduced or eliminated after that time. Table 2-5 shows the number of hospitals required to move for PFCAE-96 and PFASS by TP. The results shown in the table reflect the formulas used in the unit move program. However, to better estimate the average workload involved, the total number of movements is divided by the number of TPs in which unit relocations occur.

(3) Smoothing techniques within the PFM prevent the direct calculation of the average number of patients treated at combat support (296 beds), field (512 beds), or general hospitals (496 beds). Occasionally, there are more patients than hospital beds. An occupancy rate of 80 percent is considered near maximum based on the 15 percent "dispersion factor," that is, the availability of empty beds immediately after a patient is moved or immediately prior to a patient arriving.

Table 2-5. Hospital Relocations by Time Period

	PFCAE-96			PFASS		
	LR2	LR4		LR2	LR4	
Time period	Combat Support Hospital	Field Hospital	General Hospital	Combat Support Hospital	Field Hospital	General Hospital
3-5	N/A-->					
6	34	18	7	7	0	0
7	7	9	1	6	0	0
8	0	7	0	1	0	0
9	34	18	7	0	0	0
10	9	9	1	0	0	0
11	0	7	0	0	0	0
Average workload	84/6 = 14	68/6 = 11.33	16/6 = 2.67	14/3 = 4.67	0	0

d. **Estimate.** The total medical evacuation workload is shown in Table 2-6. The patients from Table 2-4 are totaled in the "routine" column. The number of hospitals that relocate (Table 2-5) is multiplied by 80 percent capacity and shown by hospital type.

Table 2-6. Total Medical Evacuation Workload (PFASS\PFCAE-96)

Time period	Routine	Hospital relocation Combat	Field	General	Total
3	44,457 17,753	0 0	0 0	0 0	44,457 17,753
4	83,897 38,824	0 0	0 0	0 0	83,897 38,824
5	112,185 42,681	0 0	0 0	0 0	112,185 42,681
6	101,991 41,624	8,051 1,657	7,430 0	2,666 0	120,138 43,281
7	78,353 47,269	1,658 1,421	3,715 0	381 0	84,107 48,690
8	49,037 49,606	0 237	2,890 0	0 0	51,927 49,843
9	78,320* 44,902	8,051 0	7,430 0	2,666 0	96,467 44,902
10	78,320* 41,905	2,131 0	3,715 0	381 0	84,547 41,906
11	78,320* 42,260	0 0	2,890 0	0 0	81,210 42,268
Average workload	78,320 40,758	3,315 552	4,678 0	1,015 0	

*Data adjustment (average for TP3-8).

2-6. NONCOMBATANT EVACUATION ORDER (NEO). USAREUR is responsible for providing evacuation or protection of Department of Defense (DOD)-sponsored noncombatants in the Central Region.

a. Analysis

(1) Noncombatants are either DOD-sponsored personnel (Army and Air Force dependents and support personnel) or non-DOD-sponsored (i.e., all other Americans in the Central Region).

(2) Several factors have a critical impact on NEO execution to include warning time, degree of prior planning, practice, communications, transportation infrastructure, and political circumstances. In the Central Region,

warning time and political circumstances are likely to be the major areas of concern.

(3) NEO execution depends on notification time; the more time, the more success in execution.

(a) All USAREUR and US Air Force, Europe (USAFE) communities have planned and practiced NEO operations and the communications and transportation systems are excellent.

(b) USAREUR intends to evacuate DOD-sponsored noncombatants to the greatest extent possible prior to hostilities using US nonmilitary assets. This includes use of nontactical vehicles, privately owned vehicles (POVs), contractor vehicles, etc., that are incorporated in the local military community NEO plan. USAREUR planners emphasize that tactical vehicles are excluded in NEO plans and not used during practice NEO exercises.

(c) Implicit in timely NEO execution is cooperation from the host nation. Host nation support for NEO operations has been agreed to, programmed, and practiced by the host nation. NEO execution is supported by the host nation in the USAREUR Wartime Movement Program. Even so, the possibility exists that the host nation will not provide service under certain political circumstances. In that case, individuals could be encouraged to travel on the host nation rail/highway system to designated destinations as paying customers.

(4) Responsibility for planning the evacuation of non-DOD-sponsored Americans in the Central Region falls to the US State Department. Businessmen, tourists, persons with dual citizenship, and other qualifying individuals are expected to be referred to the US Army for movement.

(5) USAREUR planners are confident that there would be no NEO participants in the division or corps areas at the outbreak of hostilities.

(6) The NEO population for PFASS, particularly DOD-sponsored NEO, should decrease as forward-stationed US combat strength is reduced.

b. Estimate. The number of non-DOD-sponsored NEO participants would fluctuate depending on the season of the year. The Department of the Army provided a current unclassified estimate for the total number of DOD and non-DOD evacuees in the Central Region of between .5 and 1.3 million personnel that is applicable to PFCAE-96. A reduction of .1 million to between .4 and 1.2 million is a reasonable estimate for PFASS.

2-7. KILLED IN ACTION (KIA). This category includes US soldiers that die as a result of all causes, combat and noncombat, in the Central Region.

a. Data Collection/Analysis

(1) Total KIA figures are derived by adding the KIA components of three FASTALS factors: those wounded in action (WIA) who die in theater hospitals; deaths from disease and nonbattle injuries (DNBI); and the killed, captured, and missing in action (KCMIA). Figure 2-2 depicts the logic in arriving at the total KIA in the theater.

```
                       ------> WIA rate  ------>   Death   ------>   WIA
                      |         /1000            rate/1000         deaths
                      |
      Total           |
   population  --->   | ----> DNBI rate  ------>   Death   ------>   DNBI
   for LR by TP       |         /1000            rate/1000         deaths
                      |
                      |
                       -----> KCMIA rate ------>  Killed   ----->   Total
                                /1000            rate/1000          killed
                                                                 --------------
                                                                  Total for LR
```

Figure 2-2. Schematic of Theater KIA Calculation

(2) The WIA component is composed of soldiers who are admitted to hospitals to recuperate from battle wounds. A fraction of those admitted will die. The rate of WIA that die as a direct result of their wounds fluctuates based on the intensity of the battle and the logical region. The rate of those soldiers hospitalized for wounds was examined by the CAA OMNIBUS-89 Study with the finding that 1.62 percent would die.

(3) The DNBI component represents soldiers who contract diseases or suffer injuries sufficiently serious to require hospitalization. A factor of 2.16/1,000/day for division soldiers and 1.20/1,000/day for nondivision soldiers has been used based on historic medical data. Of those admitted to hospitals for DNBI causes, historical medical data dictates that 0.18 percent would die.

(4) KCMIA represents soldiers whose remains have been recovered and those who are no longer present for duty because they are listed as either captured or missing as a result of contact with the enemy. The OMNIBUS-89 Study derived rates for each category. The KCMIA rates change depending on the intensity and character of the battle. The rate for those found to be killed was 783/1,000 KCMIA. Only division soldiers in LR1 are included in this category.

(5) FASTALS-generated casualty rates for authorized combat (division) population in LR1 are shown in Table 2-7. The population and rates for LR2 and LRs 3-5 are shown in Tables 2-8 and 2-9, respectively. For reasons explained during the presentation of patient evacuation, PFCAE-96 figures for TP9-11 have been revised.

Table 2-7. Combat Casualty Rates for LR1 (PFASS\PFCAE-96)

Time period	Authorized LR1 combat population	WIA/ 1000/day	DNBI/ 1000/day	KCMIA/ 1000/day
3	157,085	9.37	2.16	5.03
	174,041	2.74	2.16	1.53
4	193,310	13.51	2.16	7.02
	174,041	7.18	2.16	4.09
5	195,354	18.07	2.16	10.20
	174,041	5.95	2.16	3.26
6	235,395	12.16	2.16	7.52
	231,082	4.77	2.16	2.47
7	186,917	10.13	2.16	6.63
	280,587	4.44	2.16	2.19
8	134,486	5.87	2.16	4.20
	280,587	5.03	2.16	2.35
9	111,939	11.52*	2.16	3.01
	280,587	4.21	2.16	1.84
10	112,863	11.52*	2.16	2.00
	280,587	3.72	2.16	1.57
11	113,055	11.52*	2.16	.89
	280,587	3.95	2.16	1.72

*Indicates data adjustment - average value of TP3-8.

Table 2-8. Casualty Rates for LR2 (PFASS\PFCAE-96)

Time period	LR2 population	WIA/ 1000/day	DNBI/ 1000/day	KCMIA/ 1000/day
3	159,322	1.73	1.20	.33
	131,487	1.73	1.20	.33
4	173,395	1.73	1.20	.33
	150,420	1.73	1.20	.33
5	177,193	1.73	1.20	.33
	153,594	1.73	1.20	.33
6	212,734	1.38	1.20	.26
	191,795	1.38	1.20	.26
7	226,430	1.38	1.20	.26
	203,834	1.38	1.20	.26
8	232,171	1.38	1.20	.26
	207,176	1.38	1.20	.26
9	234,580	1.38	1.20	.26
	209,960	1.38	1.20	.26
10	235,561	1.38	1.20	.26
	212,156	1.38	1.20	.26
11	236,083	1.38	1.20	.26
	212,375	1.38	1.20	.26

Table 2-9. Casualty Rates for LR3-5 (PFASS\PFCAE-96)

Time period	LR3-5 population	WIA/ 1000/day	DNBI/ 1000/day	KCMIA/ 1000/day
3	103,316	.84	1.20	.16
	76,829	.84	1.20	.16
4	116,765	.84	1.20	.16
	86,092	.84	1.20	.16
5	121,206	.84	1.20	.16
	88,715	.84	1.20	.16
6	126,643	.69	1.20	.13
	94,516	.69	1.20	.13
7	130,005	.69	1.20	.13
	98,973	.69	1.20	.13
8	130,373	.69	1.20	.13
	100,824	.69	1.20	.13
9	131,641	.69	1.20	.13
	101,834	.69	1.20	.13
10	133,858	.69	1.20	.13
	107,014	.69	1.20	.13
11	134,127	.69	1.20	.13
	108,202	.69	1.20	.13

(6) Table 2-10 provides the results of multiplying the population for each LR by the factors for WIA, DNBI, and KIA shown in Tables 2-7, 2-8, and 2-9. The daily total is multiplied by 10 to derive the 10-day time period total (e.g., 23.8 + .6 + 618.7 = 643.1 KIA X 10 days = 6,431 KIA/TP3 in LR1). The WIA, DNBI, and KCMIA results for LR2 and LR3-5 are smaller and have been combined.

Table 2-10. Total Theater Killed in Action (PFASS\PFCAE-96)

Time period	Logical region	Died of wounds/day	Died of DNBI causes/day	KIA/ day	Total X 10 days
3	1	23.8	.6	618.7	6,431
		5.3	.7	181.9	1,879
	2,3,4,5	6.9	.6	69.1	766
		4.0	.4	55.7	601
4	1	42.3	.8	1062.6	11,057
		16.0	.5	440.1	4,568
	2,3,4,5	7.5	.6	75.9	840
		6.4	.5	63.4	703
5	1	57.2	.8	1560.2	16,180
		13.6	.5	360.3	3,746
	2,3,4,5	6.6	.6	77.9	853
		5.5	.5	65.0	715
6	1	46.4	.9	1386.0	14,333
		14.7	.9	447.1	4,627
	2,3,4,5	6.2	.7	69.8	767
		5.4	.6	62.2	682
7	1	30.7	.7	970.3	10,017
		20.2	.9	399.3	4,206
	2,3,4,5	6.7	.7	75.8	830
		5.7	.6	65.9	722
8	1	12.8	.5	442.3	4,556
		22.9	.9	428.5	4,525
	2,3,4,5	6.7	.8	77.3	848
		5.7	.7	67.0	734
9	1	20.9*	.4	263.8	2,851
		15.8	.9	335.9	3,528
	2,3,4,5	6.7	.8	78.1	856
		5.8	.7	67.8	743
10	1	21.1*	.4	176.7	1,982
		14.0	.9	286.8	3,019
	2,3,4,5	6.8	.8	78.7	863
		5.8	.7	69.1	756
11	1	21.1*	.4	78.8	1,003
		14.9	.9	314.2	3,302
	2,3,4,5	6.8	.8	78.8	864
		5.9	.7	69.3	759
Average workload	1				7,601
					3,711
	2,3,4,5				831
					712

*Denotes use of adjusted value in Table 2-7 (WIA in LR1).

b. Comment. The figures presented above do not include enemy dead, non-Army pilots, allied soldiers, and others removed from the battlefield.

2-8. MAIL. The following discussion does not include mail flowing from the COMMZ toward the FEBA. Except for data from FASTALS, discussion of this topic is based on information from the Military Postal Service (MPS) and includes its experiences from Operations Just Cause (Panama) and Desert Shield/Desert Storm (Saudi Arabia).

a. Data Collection. Mail can include both combat/free mail and support (noncombat/free) mail for all in-theater personnel, and mail for noncombatants.

(1) Combat/free mail includes both free and official mail at the time a "declaration of free mail" is made by the Secretary of the Army. Such mail is expected in all LRs at the rate of 1 pound/person/month and includes such items as official personnel, dental, and financial records sent to CONUS. One of the idiosyncrasies of NATO is that soldiers of allied nations are afforded US postal privileges in given circumstances. While not a factor in this study, the extra weight could be considerable. For example, the possibility exists that a German soldier could send household goods to an address in the US.

(2) Support or noncombat/free mail has the same characteristic as combat/free mail and is expected at the rate of 2 pounds/person/month. A large portion of this mail is expected to be contractor support Class IX repair parts for Army and Air Force equipment.

(3) Noncombatant mail includes household goods and other valuables up to a specified weight limit. Past experience provides a glimpse of the potential workload. During the Iran crisis, a weight limit of 600 lb. was imposed, but in other instances as much as 1,500-2,000 pounds of household goods weight was allowed. An individual can only ship what the Post Office will accept. The advantage of this method of extracting goods from a war zone lies in the payment of insurance claims if the packages do not arrive at the destination within 60 days. Two factors argue against a dramatic overall effect of this category of mail. The decision to limit weight to specified limits rests with the theater commander and could be made/changed at any time. Also, as indicated in paragraph 2-6, USAREUR expects most DOD-sponsored NEO personnel that remain in Central Europe to be waiting for evacuation near the APOEs without access to their personal effects.

b. Estimate. Using the factors above and FASTALS Workload 1, Total US Army Population, the amount of retrograde mail can be estimated as shown in Table 2-11 (calculation for PFCAE-96, LR1, TP3: workload/population = 184,333 x 3 pounds/month ÷ 3 time periods/month ÷ 2,000 pounds/STON = 92.2 STON). There is no allowance for NEO retrograde mail. There is also no factor for packages that may saturate the system prior to TP3. Mail is cumulative from LR1 to the theater exit point, normally an APOE in the RCZ or COMMZ.

Table 2-11. Retrograde Mail Estimate (STON) (PFASS\PFCAE-96)

LR	Time period 3	4	5	6	7	8	9	10	11
1	92.2	110.8	112.4	134.6	112.2	87.1	76.1	76.5	76.9
	69.2	78.6	80.4	107.8	132.1	132.1	132.2	132.3	132.3
2	66.0	72.6	73.9	89.5	94.5	96.3	97.2	97.6	97.6
	56.0	65.4	66.9	76.5	86.3	88.0	89.4	90.5	90.6
3	21.9	22.5	22.8	23.7	24.0	24.1	24.3	24.5	24.6
	16.1	17.5	18.2	19.4	19.8	19.8	19.9	20.9	21.0
4	28.7	34.8	36.7	38.3	39.6	39.7	40.2	41.0	41.0
	22.3	25.6	26.1	27.9	29.7	30.6	30.9	32.6	33.1
Total	208.7	240.7	245.8	286.1	270.3	247.2	237.8	239.6	240.1
	163.6	187.1	191.6	231.6	267.9	270.5	272.4	276.3	277.0

	LR1	LR2	LR3	LR4	Total
Average workload	97.6	87.2	23.6	37.8	246.2
	110.8	78.8	19.8	28.8	237.6
Cumulative workload	97.6	184.8	208.4	246.2	
	110.8	189.6	208.8	237.6	

c. Observations

(1) Mail going forward is currently not included in the workload requirement for transportation force structure.

(2) A need for special trucks to comply with postal regulations is also not accommodated.

2-9. UNIT MOVES (EXCEPT TRACKED VEHICLES). Units reposition themselves on the battlefield for many reasons. Examples are to prepare for an attack or a defense, provide better support, avoid continued casualties, become a reserve unit, reconstitute a force, and avoid hostile fire or capture. When the FEBA movement is continuously adverse as in PFCAE-96, movement for any reason tends to be in retrograde. When FEBA movement is small (PFASS), unit movement does not have a generalized forward, lateral, or retrograde characteristic. In any case, once units are initially deployed, subsequent unit movement is a transportation workload not included in current transportation force structure calculations.

a. Data Collection

(1) A discussion of the data sources and their application in a computer program used for determining unit move workload is contained in Appendix G. In brief, most data was transferred from FASTALS input and output files for both scenarios with the remainder coming from the TRADOC MARC header data. The computer program extracted nonmobile weight (NMWT), other relevant data, and employed the standard AFPDA transportation factors to calculate an output in ton-hours of required transportation support.

(2) ETRANS identifies no need for rearward movement for LRs 3-5 in the PFASS scenario. Therefore, unit moves are held at zero. In similar fashion, only 50 percent of LR2 units are allowed to move within TP3-8. No PFASS unit move occurs after TP8.

(3) The initial results of the unit move analysis described in Appendix G are shown in Table 2-12 for both scenarios. NMWT represents the potential workload generator for retrograde cargo hauled by medium trucks, while FASTALS Workload 18 represents the unit generator for medium truck companies to transport dry cargo and unit equipment moving toward the FEBA. The average is computed as the total tonnage in the LR divided by the total number of TPs that have nonzero values.

(4) The PFCAE-96 Workload 18 values decline significantly during the last five TPs. One reason for this occurrence is that the FASTALS transportation model is programmed to adjust for the rearward movement of the FEBA by reducing the number of transportation links being used.

b. Data Adjustments

(1) An adjustment to the NMWT data for LR1 was necessary to reflect that combat arms units are deemed to be 100 percent mobile on the battlefield. All NMWT for aviation, field artillery, infantry, and armor units was entered as zero for subsequent calculations. Combat engineer units were also adjusted to zero. This alteration reduced the average LR1 NMWT value in Table 2-12 by a factor of 15.

(2) The adjusted values for LR1 and the values for LR2-4 shown in Table 2-12 are considered to be understated for four reasons. First, all NMWT for combat units was purposefully deleted, but there may, in fact, be some legitimate NMWT attributable to those units. Second, units move away from the FEBA for other than retrograde specific purposes. PFASS in particular is abnormally low because the FEBA is not moving, but unit moves will still be necessary, some of which may be rearward. Third, NMWT constitutes only a portion of the total weight that a unit has onhand. And fourth, the current transportation force structure determination process, as implemented in FASTALS, does not consider unit moves (other than initial deployments) as a transportation workload.

Table 2-12. NMWT vs FASTALS Wkld 18 (000 STON-hours) (PFASS\PFCAE-96)

	LR1		LR2		LR3		LR4	
TP	NMWT	Wkld 18	NMWT	Wkld 18	NMWT	Wkld 18	NMWT	Wkld 18
3	129.7	69.3	11.8	243.5	3.5	180.4	.1	31.3
	34.0	150.9	.1	60.4	0	399.2	0	32.4
4	180.4	153.6	40.0	332.3	17.0	258.6	1.6	52.9
	34.0	81.6	2.1	68.6	0	161.6	0	32.8
5	244.5	209.3	71.7	430.2	17.0	152.6	2.2	65.7
	34.0	120.2	4.7	96.0	0	215.0	0	40.2
6	224.0	239.1	50.5	593.0	21.2	281.8	3.4	361.6
	64.4	176.6	7.3	149.8	0	297.4	0	44.8
7	315.0	182.3	36.7	572.5	13.1	286.0	2.4	166.0
	51.4	181.4	4.2	220.3	0	300.0	0	41.6
8	401.7	115.2	81.9	348.0	22.5	143.9	3.4	43.7
	0	160.6	6.0	242.4	0	255.7	0	49.9
9	384.2	69.9	61.7	230.6	24.4	144.0	4.1	53.7
	0	159.4	0	248.2	0	283.7	0	85.0
10	426.6	37.3	61.8	134.3	12.7	82.4	2.6	29.7
	0	152.1	0	127.1	0	285.2	0	50.3
11	454.7	27.6	67.2	99.9	17.3	64.1	2.3	22.5
	0	138.6	0	116.8	0	248.1	0	41.2
Average workload	306.8	122.6	53.7	331.6	16.5	174.1	2.5	91.9
	41.6	146.8	4.1	147.7	0	271.7	0	46.5

(3) NMWT is the only statistic available to measure unit move workload. It is the weight of table of organization and equipment (TOE) equipment remaining after unit wheeled vehicles have been loaded with TOE equipment and departed for the new location. NMWT may understate the actual weight required to move because it does not include items listed in Table 2-13. Additionally, understating weight may result because movement will not always be exactly forward and rearward relative to the FEBA (causing added mileage to the FASTALS transportation formula). TOE vehicles may be in maintenance or battle-damaged and unable to carry their share of the unit's equipment. Also, the environment may be more adverse than anticipated (e.g., nuclear, biological and chemical (NBC) factors).

Table 2-13. Factors That Increase NMWT

Common Table of Allowance (CTA) Equipment
Basic Load - Ammunition, Rations, Medical
Unit Supply - Consumables
Publications, Forms, Files, and Records
Repair Parts, Bench Stock
Mission Workload/Inventories - QM and ORD Units
Float Equipment - Ordnance Units
Environmental Equipment - NBC, Desert, Arctic
Personal Effects

(4) An observation expressed by Transportation School representatives is that units in the corps, RCZ, and COMMZ units appear to be less mobile than those in the division. Also, the ratio of CTA and associated equipment to TOE equipment appears to increase from division through COMMZ.

(5) Conversely, NMWT may be an overstatement of the actual weight needing supporting transportation movement for several reasons. The unit cargo vehicles may be able to make more than one sortie between the new and old location. A unit having adequate warning time could be more efficient or take advantage of "opportune lifts" to move equipment. During the course of the battle, nonmobile TOE items may be destroyed and left behind. Slow-moving vehicles that are usually carried on trailers may move on their own. Lastly, the possibility of rail movement of selected items may reduce truck requirements. On balance, however, rail should not be expected to play any significant role because the effort to get nonmobile items to and from the origin and destination railheads may more than offset the advantage that rail may afford.

(6) Inquiries of the Ordnance, Quartermaster, and Transportation Schools indicated that no studies or estimates exist that address the issue of total unit weight during battlefield movement.

(a) The closest available weight figure that may be reflective of unit weight on the battlefield is the deployment weight that each unit in the US reports to the MTMC. However, this weight, the Computerized Movement Planning and Status System (COMPASS), is deemed inappropriate for several reasons. The COMPASS weights are administrative in nature, and they are oriented toward determining the total unit transportation requirements by rail or ship. The total weight includes wheeled and tracked vehicles and aircraft that should be excluded in battlefield moves. COMPASS weights exclude items acquired in theater such as ammunition and supplies needed for continuous operations against the enemy.

(b) Several Transportation School combat development representatives deliberated at length to arrive at a factor for "other than NMWT." Many aspects of the problem were considered and estimated with the determination that a factor of 428 pounds per soldier in LR1 and 623 pounds per soldier in LRs 2-4 was appropriate.

(7) Figure 2-3 shows the effect in LR1 of the two changes in unit weight, removing the NMWT of the combat units and adding the 428 pounds per soldier. The "other than NMWT" is a significant addition to NMWT. Removing the NMWT of the combat units probably did not also totally remove the actual requirement for transport of "other than NMWT." Those noncombat units remaining in LR1 can be expected to have a higher portion of "other than NMWT" because they are less likely to be 100 percent mobile on the battlefield. The estimated weight of 428 pounds per soldier may be significantly in error. Therefore, the two broken lines have been added to show the relative effect of the "other than NMWT" if the actual additional weight is 50 percent below or 50 percent above the 428-pound estimate.

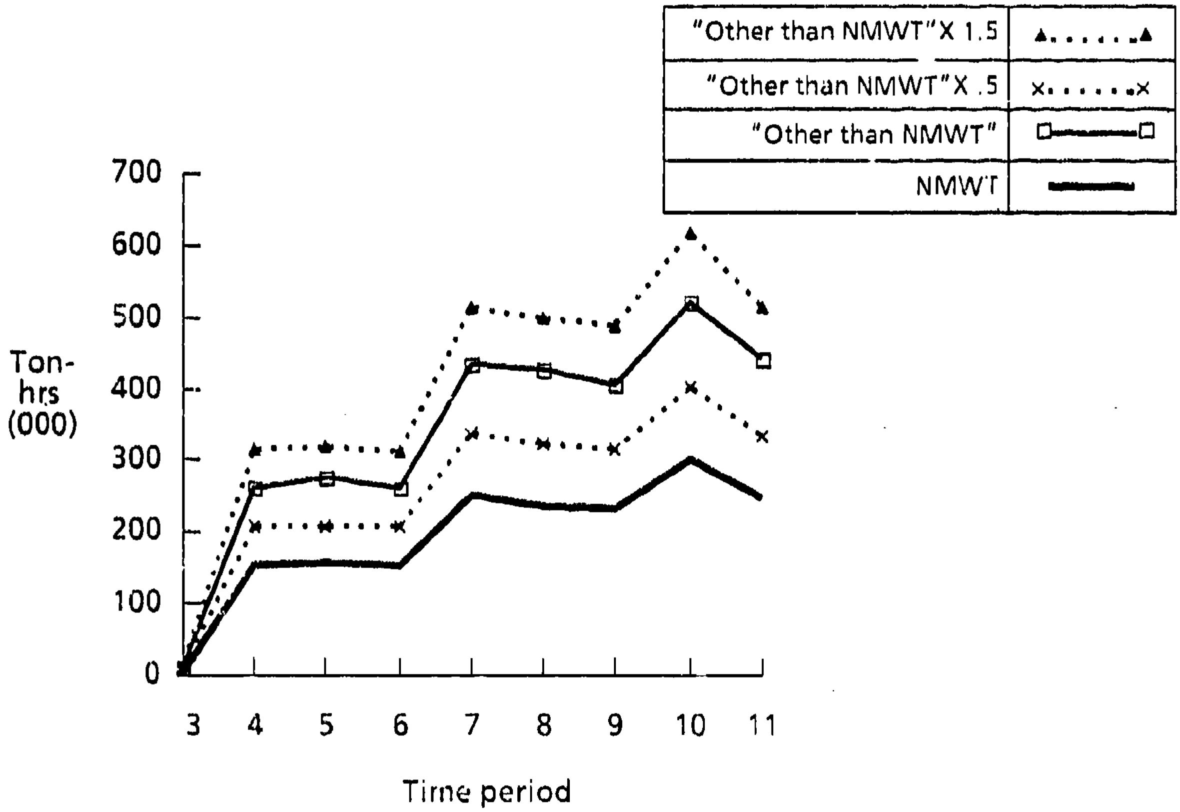

Figure 2-3. PFASS NMWT and "Other than NMWT" for LR1

(8) In comparison to Figure 2-3, Figure 2-4 shows the relative NMWT and "other than NMWT" curves for LR3 for PFCAE-96. "Other than NMWT" is a smaller proportion of the total, reflecting that units in LR3 have more NMWT in the TOE. The estimate of 623 pounds per soldier is greater than that in LR1 but has a small impact on total transportation requirements.

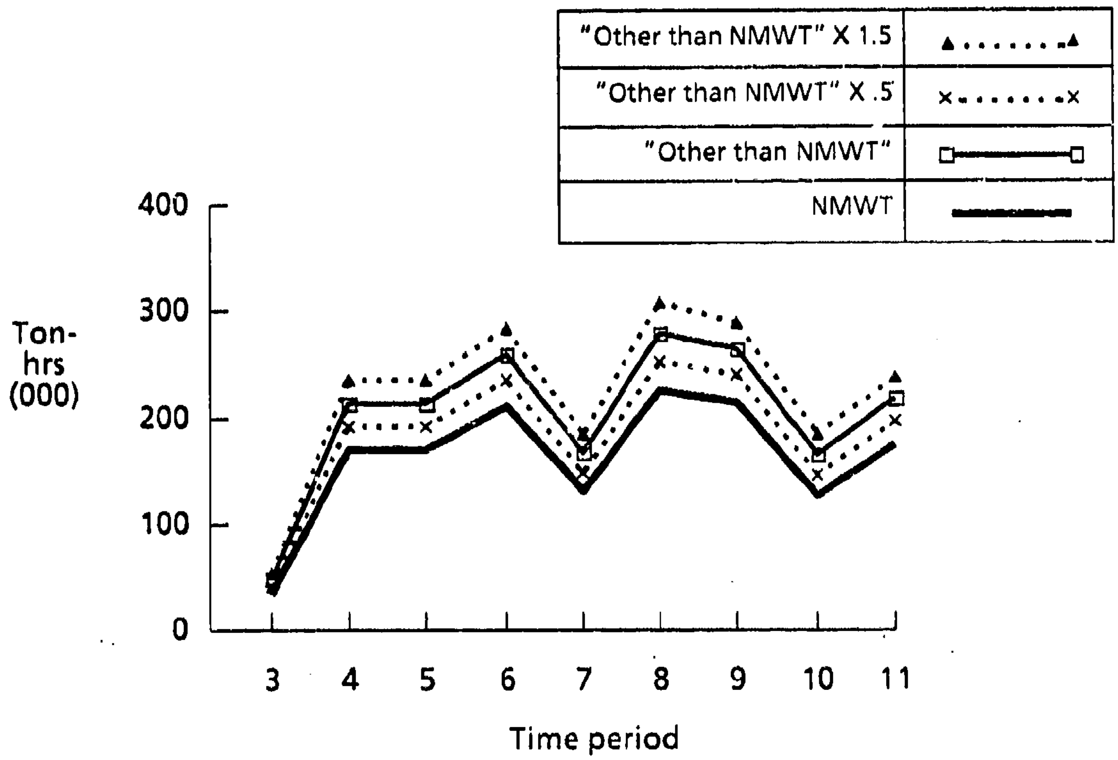

Figure 2-4. PFCAE-96 NMWT and "Other than NMWT" for LR3

(9) Table 2-14 provides the tonnage for the "other than NMWT" factor. The weight was tabulated and processed into the unit move program. The results are shown in Table 2-16. As only half the PFASS LR2 units are estimated to move, results for PFASS in Tables 2-14 through 2-16 are half the total calculated results.

Table 2-14. "Other Than NMWT" Estimate (000 STON) (PFASS\PFCAE-96)

LR	Time period								
	3	4	5	6	7	8	9	10	11
1	23.1	31.2	42.7	37.7	48.2	59.8	52.6	59.2	65.7
	0.0	28.0	30.2	28.0	47.1	46.1	43.7	57.0	48.6
2	35.8	70.7	86.4	75.6	88.0	110.2	95.2	105.3	107.9
	1.1	16.6	21.0	16.3	26.1	27.7	21.1	27.6	31.1
3	6.6	16.6	16.7	12.8	13.9	19.3	13.1	15.2	15.9
	0	0	0	0	0	0	0	0	0
4	1.3	7.8	9.0	12.6	10.7	13.4	12.1	11.9	9.3
	0	0	0	0	0	0	0	0	0

(10) The "other than NMWT" figures are expressed in terms of tons, not ton-hours as in Table 2-12. To sum this amount with NMWT, both figures must be in terms of tons. Table 2-15 provides a conversion to tons for the NMWT figures in Table 2-12. The NMWT values for combat units have been deleted.

Table 2-15. NMWT (000 STON) (PFASS\PFCAE-96)

LR	Time period								
	3	4	5	6	7	8	9	10	11
1	33.9	45.2	62.8	55.6	69.0	85.4	75.5	83.4	93.4
	0.0	43.1	43.4	43.0	69.6	64.8	64.5	83.0	68.0
2	37.1	76.1	101.4	80.5	81.4	123.0	103.0	113.6	113.7
	1.8	21.2	34.2	35.9	36.8	45.3	46.8	50.0	47.6
3	17.8	56.2	53.2	62.4	44.9	66.9	62.9	44.6	54.7
	0	0	0	0	0	0	0	0	0
4	.7	7.6	7.9	11.1	7.7	11.6	11.5	9.7	7.9
	0	0	0	0	0	0	0	0	0

c. **Estimate.** The estimated weight in Table 2-16 reflects the effects of both the LR1 combat unit weight reduction and the addition of the "other than NMWT" factors.

Table 2-16. Total Unit Move Weight (000 STON) (PFASS\PFCAE-96)

LR	Time period 3	4	5	6	7	8	9	10	11
1	57.1	76.4	105.5	93.4	117.2	145.2	128.0	142.6	159.2
	0.0	71.1	73.6	71.0	116.7	110.9	108.2	140.0	116.6
2	73.0	146.8	187.9	156.0	168.4	233.2	198.2	218.9	221.5
	2.9	37.8	55.2	52.2	62.9	73.0	67.9	77.6	78.7
3	24.4	72.8	69.9	75.2	58.8	86.2	76.0	59.8	70.7
	0	0	0	0	0	0	0	0	0
4	2.0	15.4	16.9	23.7	18.4	25.0	23.6	21.5	17.2
	0	0	0	0	0	0	0	0	0

		PFCAE-96	PFASS
Average for TP3-11:	LR1 =	113,800 STON	89,800 STON
	LR2 =	178,200 "	56,500 "
	LR3 =	66,000 "	0 "
	LR4 =	18,200 "	0 "

d. **Observation.** The study did not find any previous analysis or institutional knowledge of unit move requirements. This is a failing that needs review because not only do unit moves amount to a large workload, but also because the reference data needed to provide a good estimate are not developed.

2-10. SUPPLY AND AMMUNITION STOCKS. This topic complements the unit move discussion above because it represents the on-the-ground stocks that Quartermaster and Ordnance units need to move when they must reposition on the battlefield. As with unit moves, movement of stocks can be examined from several different viewpoints. In this analysis, determining requirements is based on FASTALS data.

a. **Division and Corps.** The current FASTALS play dictates that all supplies remaining in a physical region are lost when the physical region is vacated by NATO forces. Physical regions are subsets of logical regions that enable FASTALS to compartmentalize the battlefield to better depict support activities.

(1) FASTALS output provides a status at the end of each TP by providing the amount of supplies consumed in each of 21 physical regions for the 10-day period and the quantity on the ground at the end of the TP. A PFCAE-96 extract of the FASTALS "Requirements for Resupply by Region" report for TP3 for the division and corps is shown in Table 2-17. The battle has progressed to the degree that LRs 1 and 2 have been displaced rearward to the degree that physical regions 1-4 and 6-7 have been lost to the enemy. Physical regions 14-21 are assigned to the RCZ or higher activities and are not shown.

Table 2-17. PFCAE-96 Resupply Report for Class I, TP3 (STON)

Physical region		Tonnage	Logical region
1	Consumed	0	Lost
	Storage	0	
2	Consumed	0	Lost
	Storage	0	
3	Consumed	0	Lost
	Storage	0	
4	Consumed	0	Lost
	Storage	0	
5	Consumed	1550	1
	Storage	310	
6	Consumed	0	Lost
	Storage	0	
7	Consumed	0	Lost
	Storage	0	
8	Consumed	1454	2
	Storage	897	
9	Consumed	2626	1
	Storage	525	
10	Consumed	1640	1
	Storage	1660	
11	Consumed	0	2
	Storage	1000	
12	Consumed	1889	2
	Storage	2635	
13	Consumed	1121	2
	Storage	5194	

(2) A spreadsheet analysis (see Appendix I for example) was performed for all classes of supply consisting of dry cargo for TP3-11 to determine the amount of supplies that needed to be relocated when the division and corps physical regions were threatened.

(a) Division supply requirements equal to the FASTALS programmed supply policy were subtracted (e.g., the division needed a 2-day supply of Class I onhand at all times). The normal daily corps consumption was also determined and subtracted from corps stocks. For example, in physical region 5 (division), two times the daily consumption of 155 short tons (310 STON, in this case, the exact amount in storage) were not included for retrograde movement, and in physical region 8 (corps), two times the daily consumption of 145.4 short tons was subtracted.

(b) The daily supplies normally needed by the division during a predetermined warning time were also subtracted from either excess division stocks or, if insufficient, corps stocks. When the warning time was 2 days, a second 310 tons were subtracted from corps stocks to satisfy the need for physical region 5.

(c) To provide a sensitivity test, the results were determined with the assumption that corps storage activities would be given either a 2- or 4-day warning in advance of movement. The results for the example shown in Table 2-17 were that 9,002 STON of Class I needed to be moved if there were 2 days of warning, and 6,946 STON needed to be moved if there were 4 days of advanced warning.

(3) Table 2-18 provides a listing of tonnage to be moved by supply class for each TP, given a 2-day warning period in a given TP. Medical supplies (Class VIII) are a relatively small amount and should be carried by the combat support hospitals while they are moving. Class III bulk is shown below the total because it is not dry cargo. It will be moved by tanker trucks, pipeline, and host nation rail. Additionally, Class VII was not included in the totals because a large portion of its items will move under their own power. Negative figures were not subtracted from the total because a negative number represents a workload to be transported forward even though the corps is moving to the rear. The 2-day warning time tonnage is compared with a 4-day warning time tonnage in paragraph 3-10, Chapter 3. The 9,002 STON for Class I for TP3 is rounded to 9.0K STON.

(4) The corps in PFCAE-96 would need to move an average of 118,600 STON each time the corps stocks were moved. The number of moves in a 90-day period is discussed in Chapter 3. However, to follow the convention used earlier, the unit move code of a QM general supply company is "D," 29 days; therefore, the company and the supply stocks would move three times in the 90-day campaign. If applied for all supplies except Class IIIB and VII, total tonnage would be 355,800 (3 moves X 118,600 STON). The PFASS corps would need to move an average of 196,000 STON. Again, following the logic presented earlier, only half the corps stocks would be moved during TP3-8. PFASS tonnage would be 98,000 STON. (Alternatively, the average for PFASS TP3-8 is 214,400 and half of that is 107,200 STON.)

Table 2-18. FASTALS Supply Levels by TP
(000 STON) (PFASS\PFCAE-96)

Supply class	Time period 3	4	5	6	7	8	9	10	11
I	9.0	5.9	4.7	5.3	5.5	5.0	4.8	6.8	6.8
	13.5	11.6	10.7	10.5	10.8	9.2	9.1	10.9	10.9
II	22.4	15.7	9.5	7.3	4.5	3.1	2.6	3.6	3.6
	34.6	27.1	23.7	19.5	15.0	13.1	12.2	11.0	9.9
IIIP	4.6	2.6	1.8	1.2	.7	.5	.4	.5	.5
	7.6	5.9	5.2	4.5	3.8	3.3	3.0	2.8	2.6
IV	9.4	5.5	5.8	6.5	6.8	6.2	6.0	8.4	8.4
	21.2	15.8	13.4	13.1	11.1	11.3	11.3	13.6	13.2
V	168.5	60.5	31.0	66.5	86.5	98.1	98.9	97.2	96.7
	273.9	187.7	160.5	135.5	125.4	119.5	120.2	105.9	107.6
VI	-.6	-.7	-.7	-.8	-.8	1.5	1.4	1.5	1.5
	-.4	-.6	-.6	-.7	-.9	2.3	1.7	1.7	1.7
IXALOC	2.0	2.5	3.0	2.8	2.9	2.6	2.3	2.0	1.5
	1.2	1.9	2.0	2.1	2.4	2.5	2.5	2.4	2.4
IXNALOC	10.3	5.8	4.1	2.9	3.0	2.6	2.4	1.7	1.7
	16.5	12.0	10.9	9.3	8.3	8.0	7.1	6.7	6.7
Total	226.2	98.5	59.9	92.5	109.9	119.6	118.8	121.7	120.7
	257.7	262.0	226.4	194.5	176.8	169.2	167.1	155.0	155.0
TP average: PFCAE-96 = 118,600, PFASS = 196,000 STON									
IIIB	103.9	16.6	30.3	10.0	10.0	12.2	14.6	18.1	18.1
	155.7	103.6	104.3	104.4	93.3	68.0	69.2	64.7	69.7
VII	28.4	-11.1	-18.6	-18.3	-17.7	-15.8	-12.7	-9.8	-9.8
	82.2	44.3	43.8	42.9	39.9	39.0	39.7	18.9	12.0

b. RCZ and COMMZ

(1) Supplies and ammunition are prepositioned throughout the Central Region, much of it at echelons above corps. Additional stocks will enter the Central Region throughout the conflict. Detailed plans are in place for the forward movement of these items during wartime. For prepositioned stocks, rail is the predominant mode of transportation to execute depot outload plans, with both depot and host nation vehicles servicing the origin railhead.

(2) At an average of 7.2 km/day, the PFCAE-96 FEBA moves through the major RCZ and COMMZ depot sites in 25-35 days. For study purposes, a 4-day warning time is allowed prior to depot relocation. Therefore, 4 days of consumption is subtracted from the total tonnage that the depots must move. Table 2-19 shows the total tons to be moved, given that the depots move only once in the 90-day period and that the depots are in LR4. This set of conditions combines the ETRANS unit move code value for a depot (30 days) with the fact that large adverse FEBA movement dictates earlier movement than normally expected in the unit move analysis.

Table 2-19. PFCAE-96 Supply and Ammunition Movement during TP4 for LR3-4 (000 STON)

Class I	II	IIIP	IV	V	VI	IXALOC	IXNALOC	Subtotal
8.1	12.0	11.7	1.2	236.1	-1.3	.3	21.0	290.4
		IIIB		VII	VIII			
		643.7		11.4	6.7			661.8
							Total	952.2

(3) The PFASS FEBA never penetrates the RCZ or COMMZ, and there is no need to move supplies in these areas to the rear to avoid capture.

2-11. CLASS VII AND IX PARTS. Vehicles, aircraft, and generators are examples of equipment that require replacement parts due to the effects of combat or because of RAM deficiencies. Many of the engines, transmissions, rotor blades, black boxes, and other high-dollar, high-technology items are recoverable and must be shipped back to maintenance facilities for reconditioning. A subset of this requirement, but not included in this study, is the retrograde of maintenance equipment (e.g., tools and calibration devices) for repair and calibration.

a. Data. The US Army Materiel Systems Analysis Agency (AMSAA) is the Army activity charged with tracking and estimating usage of repair parts. CAA requested data to support an analysis of the weight of end item component parts to be retrograded.

(1) A major limiting factor was that the CEM Logistics Report counts only the major tracked vehicles and certain aircraft. All other component parts of other systems had to be estimated.

(2) AMSAA provided estimates for the major tracked vehicles that have sufficient historical data available. Vehicles without a satisfactory data base are placed in the vehicle maintenance profile that fits them best.

(3) The data was provided in a format that indicated the average number of pounds of component parts that are expected to be repaired at organization, direct support (DS), general support (GS), or depot during a single "maintenance event." A maintenance event occurs each time a vehicle is counted as combat damaged or inoperable for RAM deficiencies by the CEM Logistics Report. A sample of the weight data contained on page E-10, Appendix E, is shown in Table 2-20. SPARC is the acronym for Sustainability Predictions for Army Spare Components for combat, the method used to simulate the effects of combat damage.

Table 2-20. Average Weight of Parts Repaired by Location for M60A3 (lbs)

Type	Org	DS	GS	Depot
SPARC	40	110	105	860
RAM	330	205	105	195

(4) Table 2-21 displays the results of the spreadsheet for the weight of repair parts for tracked vehicles to be retrograded. For study purposes, the location of the GS facility is in the RCZ/COMMZ.

Table 2-21. Retrograde Tonnage of Repair Parts for Tracked Vehicles (STON/day) (PFASS\PFCAE-96)

TP	CP and org to DS (LR1)	DS to GS (LR1 to LR3/4)	DS to depot (LR1 to LR3-4)	GS to depot (LR3/4 to LR4)
3	130.49 144.97	61.76 42.19	74.23 120.34	41.42 15.83
4	197.29 341.68	96.23 84.98	116.92 303.30	78.76 56.08
5	224.03 257.23	147.76 69.48	167.25 217.62	128.61 37.18
6	374.79 242.46	183.09 74.21	248.91 193.42	176.15 33.00
7	219.78 254.30	182.54 94.86	201.75 180.59	149.05 36.12
8	290.68 304.29	172.49 106.38	150.58 225.30	93.87 46.26
9	195.19 239.20	123.45 98.58	91.27 156.20	56.59 35.78
10	134.26 199.03	92.12 92.40	51.00 116.57	33.55 29.67
11	97.30 198.70	70.65 91.79	31.09 117.40	20.22 29.71

(5) In addition to the tracked vehicle parts to be evacuated, parts from wheeled vehicles, aircraft, and other equipment also must be considered. Table 2-22 provides the estimates that AMSAA developed to accommodate the requirement to transport parts tonnage for other than tracked vehicles. The weight of the packaging (e.g., an engine or rotor blade container) is included in the estimate.

Table 2-22. Proportional Tonnage of Parts Factors for Wheeled Vehicles and Aircraft (PFASS\PFCAE-96)

	Org	DS	GS	Depot
Wheeled vehicles	.002 .002	.019 .019	.036 .036	.008 .008
	AVUM		**AVIM**	**Depot**
Aircraft	.58 .45		.95 .74	.21 .16

(a) The factors for wheeled vehicles is based on the relative densities of wheeled versus tracked vehicles. The results for tracked vehicles provided in Table 2-21 were multiplied by the applicable factor in Table 2-22 to derive the values in Table 2-23. Logic is explained in paragraph 2-11b. The following calculation is based on the premise that parts from a vehicle repaired at organizational maintenance generates parts for DS, GS, and depot. For example, the 8.22 tons/day from the "CP and Org to DS (LR1)" column was figured as follows: .019 DS + .036 GS + .008 depot = .063 X 130.49 tonnage for tracked vehicles = 8.22. AMSAA indicated that the PFCAE-96 and PFASS values for wheeled vehicles are the same.

(b) The factor for aircraft is based on the repair parts weight of only the M1 tank systems. To generate this number, CAA provided the number and type of tank and aircraft battalions for each scenario to AMSAA. The aircraft values are different largely because the mix of tanks changes between the scenarios. A program was written at AMSAA to derive the relative tonnage of repair parts between the M1 and all aircraft from which the factors were developed. The DS and GS parts were combined to reflect the current three level aircraft maintenance system. Aviation results are also included in Table 2-23.

(c) No parts other than for vehicles and aircraft are included in this study; however, the total tonnage for other end item repair parts is thought to be very small in comparison to that for vehicles and aircraft.

Table 2-23. Repair Parts Tonnage for Wheeled Vehicles and Aircraft (STON/day) (PFASS\PFCAE-96)

TP	CP and org to DS/AVIM (LR1)		DS to GS (LR1 to LR3/4)	DS/AVIM to depot (LR1 to LR3/4)		GS to depot (LR3/4 to LR4)	
	W/V	A/C	W/V	W/V	A/C	W/V	A/C
3	8.22	25.52	2.22	.59	11.83	.33	.69
	9.13	38.68	1.52	.96	33.66	.12	.30
4	12.43	33.79	3.46	.94	15.60	.63	1.08
	21.53	92.44	3.06	2.43	113.14	.45	.80
5	14.11	40.39	5.32	1.34	18.24	1.03	1.46
	16.21	69.42	2.50	1.74	60.15	.30	.66
6	23.61	39.73	6.59	1.99	17.84	1.41	1.41
	15.27	59.66	2.67	1.55	51.91	.26	.51
7	13.85	29.21	6.57	1.61	13.26	1.19	.78
	16.02	51.43	3.41	1.44	44.97	.29	.37
8	18.31	22.08	6.21	1.20	10.84	.75	.44
	19.17	51.84	3.83	1.80	45.20	.37	.38
9	12.30	14.06	4.44	.73	6.50	.45	.37
	15.07	34.64	3.55	1.25	30.73	.29	.18
10	8.46	8.35	3.32	.41	4.04	.27	.07
	12.54	28.31	3.33	.93	25.44	.24	.12
11	6.13	4.96	2.54	.25	1.27	.16	.03
	12.52	30.53	3.30	.94	27.24	.24	.13

b. Analysis

(1) Only parts shipment rearward is counted. Referring to Table 2-20 for example, if a combat damaged vehicle is evacuated to DS and repaired, 105 pounds of parts are removed at DS and shipped to the general support facility. The 40 pounds of parts may or may not be shipped to the organization for repair, but they will not be included in the total because the 40 pounds are being shipped forward.

(2) All parts generated by unit maintenance to be shipped to higher maintenance levels are initially shipped to DS for consolidation.

(3) The study used an altered form of the spreadsheet used for the HET analysis calculation described in Appendix F to determine the weight for both scenarios.

(a) The maintenance distribution format was kept. When the CEM 4-day combat loss data figures were entered and multiplied by the maintenance distribution, the result provided the number of maintenance events for the period.

(b) Line 24, Theater Reserve to Unit, was then replaced with PARTS (ORG, DS, GS, Depot)-SPARC and PARTS (ORG, DS, GS, Depot)-RAM using the AMSAA data for the several vehicles tracked by the FASTALS Logistic Report. This calculation produced the pounds of parts shipped per maintenance event. By accruing the retrograde tonnage by LR and dividing by 4 days, the daily tonnage for rearward shipment of repair parts can be determined.

(c) Tracked vehicles salvaged at the collection point (CP) were considered to have no salvageable parts. However, the repair parts weights were doubled for vehicles that were evacuated to other levels of maintenance. AMSAA suggested this approach informally because it is thought that any vehicle evacuated to CP but not repaired or evacuated would be determined unrepairable, and no time would be spent on it. Alternatively, a vehicle evacuated to organization or higher was considered repairable at the CP or had sufficient value to warrant being moved and substantial repair effort may accrue prior to its salvage.

c. Estimate. Table 2-24 combines the daily repair parts tonnage for tracked and wheeled vehicles and aircraft to be retrograded to higher maintenance organizations.

2-12. MAINTENANCE EVACUATION (TRACKED VEHICLES). The object of analysis for this topic is not to determine the number of tons of vehicles being evacuated, but the number of lifts needed by HETs to perform the evacuation. HETs can carry tracked and wheeled vehicles and all manner of cargo and outsized equipment. However, in this study, only damaged tanks, armored personnel carriers (APCs), and artillery are considered. A HET can often carry two light tracked vehicles, but for study purposes, only one *damaged* vehicle is transported per sortie.

a. Data. Data was drawn from CAA and TRADOC sources.

(1) All data designating the number of damaged or destroyed tracked vehicles is drawn directly from the CEM Logistics Report for the particular scenario. Four data elements were of interest for retrograde analysis: temporary combat losses, permanent combat losses, temporary noncombat (RAM) losses, and permanent noncombat (RAM) losses. Additionally, vehicles released from theater stocks were also included since they generate HET requirements and a demand for vehicles.

(2) The US Army Transportation School at Fort Eustis, VA, supplied data concerning the transportation aspects of HET operations in the European theater.

Table 2-24. Total Weight of Repair Parts for Retrograde (STON/day) (PFASS\PFCAE-96)

TP	CP and org to DS/AVIM (LR1)	DS to GS (LR1 to LR3/4)	DS/AVIM to depot (LR1 to LR3/4)	GS to depot (LR3/4 to LR4)
3	164.23 192.78	63.98 43.71	86.65 154.96	42.44 16.25
4	243.51 455.65	99.69 88.04	133.46 418.87	80.47 57.33
5	278.53 342.86	153.08 71.98	186.83 279.51	131.10 38.14
6	438.13 317.39	189.11 76.88	268.74 246.88	178.97 33.77
7	262.84 321.75	189.11 98.27	216.62 227.00	151.02 36.25
8	331.07 375.30	178.70 110.21	162.62 272.30	95.06 47.01
9	221.55 288.91	127.89 102.13	98.50 188.18	57.41 36.25
10	151.07 239.88	95.44 95.73	55.45 142.94	33.89 30.03
11	108.39 241.75	73.19 95.09	32.61 145.58	20.41 31.08
Average workload	244.32 308.47	130.08 86.89	137.94 230.69	87.86 36.18

(3) AMSAA supplied data on the expected maintenance profile of tracked combat vehicles based on SPARC and RAM data. Maintenance data was provided to reflect the differences between a static FEBA and a FEBA that is moving to the rear. This was of significant value because it allowed for a more precise differentiation between PFCAE-96 (defensive) and PFASS (static).

b. Analysis

(1) A spreadsheet reflecting transportation needs was developed to count both forward and retrograde movements. HETs and rail requirements are accumulated by specific events, e.g., transport from DS to GS, and totaled over the 90-day period.

(2) A FORTRAN program was written to manage the data requirements of the spreadsheet. The results combine tracked vehicle losses extracted by 4-day time segments with maintenance repair requirements. The program consolidated results by weapon category (armor, APC, and artillery) for each time period. Figure 2-5 provides an overview of the inputs and outputs of the HET analysis spreadsheet which is discussed in detail in Appendix F.

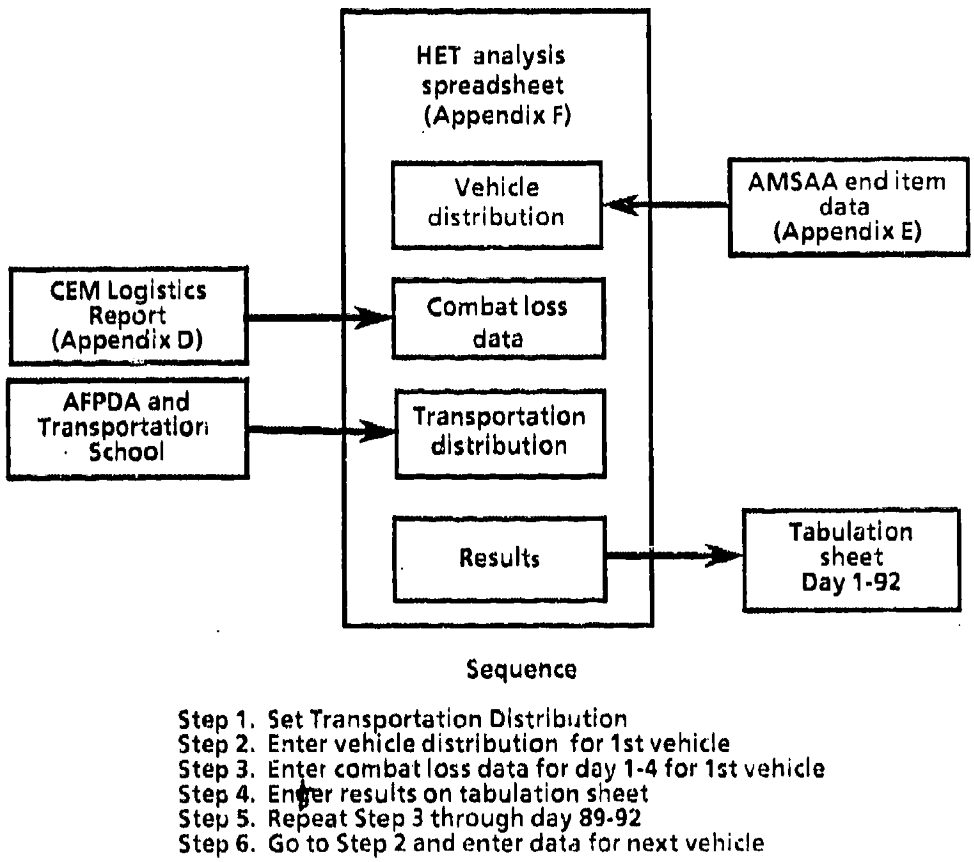

Figure 2-5. Schematic of Process to Determine HET Requirements

(3) A base case was developed for each scenario. Several alternative situations are developed, and the results are shown in Chapter 5.

(4) Several factors significantly affect the results.

(a) A large percentage of maintenance (between 32 percent and 61 percent of all damaged vehicles) is performed in the unit maintenance collection point (UMCP) by organizational and DS maintenance teams. The effects of the "fix far forward" maintenance policy is forcefully demonstrated.

(b) No PFCAE-96 K-kill or abandoned vehicles are moved off the battlefield.

(c) Every move from the UMCP rearward is performed by a HET. Recovery vehicles only move vehicles from the damage site to the UMCP.

(d) No HETs are used to move operational vehicles in the division area. This reduces the opportunity for backhauls. Vehicles arriving from GS or theater stocks are brought to the Division Support Command (DISCOM) to be matched with crews who drive the vehicles toward the FEBA.

(e) The maintenance doctrine of fixing equipment as far forward as possible results in relatively few vehicles transported to GS and none transported by HET to depot.

(5) The base case has the potential for understating HET requirements for several reasons.

(a) It is reasonable to believe that a PFCAE-96 type defensive scenario would incur more evacuation to higher maintenance levels to prevent possible capture while delay for parts or waiting in the maintenance queue prevents immediate repair at the unit or collection point.

(b) No use is made of either backup DS or the GS capability for DS work because no data was available at AMSAA.

(c) AMSAA provided no values for depot repair for other than components.

(d) The vast majority of permanent combat losses for PFCAE-96 never get off the battlefield. Most permanent combat losses are salvaged at the UMCP.

(e) The CEM Logistics Report is constructed such that every vehicle having temporary damage is returned to duty after four days. On average, this treatment appears at variance with anticipated return rates of vehicles repaired at the CP and organizational levels. If this observation is true, fewer vehicles are in the fight than would be expected than when maintenance times are shorter than 4 days. Alternatively, a 4-day turnaround time for maintenance would usually dictate an evacuation to a DS or possibly GS level for repair.

c. **Estimate.** Refer to Chapter 5 for an expanded treatment of results.

(1) HET results are indicated in Table 2-25. The CEM Logistics Report is divided into 4-day segments but has been adjusted to reflect the same TPs as all other subjects in this chapter.

Table 2-25. HET Spreadsheet Results (PFASS\PFCAE-96)

TP	Total lifts in LR1	Total lifts in LR2-4	Percent local haul in LR1	Percent local haul in LR2-4
3	1904.07 840.80	156.66 35.09	78.91 90.71	93.84 98.19
4	2797.56 1784.11	214.17 64.92	78.58 90.02	92.75 97.04
5	3847.51 1492.62	293.15 57.93	78.78 89.99	91.66 97.15
6	4445.42 1482.71	329.54 59.57	79.32 90.47	91.05 97.01
7	3985.25 1665.16	289.20 69.06	80.27 90.71	91.30 96.73
8	3490.51 1918.36	238.93 82.70	80.90 91.01	80.56 81.41
9	2292.71 1698.61	158.02 79.07	82.08 91.11	77.78 77.78
10	1608.90 1527.99	104.64 69.32	82.87 91.27	77.78 77.78
11	1156.15 1509.63	70.64 65.38	83.80 91.47	77.78 77.78
Average workload	2836.45 1546.67	206.11 64.89	80.61 90.75	86.06 88.99

(2) The estimate above is a composite result that includes tanks, APCs, and artillery. The individual weapon system results were asymmetrical, and Table 2-26 provides an illustration of results grouped by weapon type for the most active 4-day TP.

Table 2-26. HET Spreadsheet Results by Weapon Type (PFASS\PFCAE-96)

Weapon type	Total lifts in LR1	Total lifts in LR2-4	Percent local haul in LR1	Percent local haul in LR2-4
Tank	694.24	97.27	73.90	82.87
	223.62	2.57	98.38	98.17
APC	1220.31	47.55	80.95	94.24
	595.27	23.07	83.68	95.58
Artillery	9.80	5.25	81.91	95.72
	13.59	2.68	89.44	95.77

d. Observation. This analysis highlights the difficulty of accurately determining credible answers to the problem of estimating HET use. Many sources of data, credible assumptions, and overall synchronization of all elements are needed to derive usable results.

2-13. UNIT MOVES (TRACKED VEHICLES). This topic is closely associated with paragraph 2-12, since it also relates to the use of HETs for maintenance evacuation. The difference is that it isolates on HET use only when a maintenance activity must relocate and move the tracked vehicles that are either in the process of repair or awaiting repair in a maintenance queue. It is emphasized that a proper treatment of this subject requires data specifically targeted to this problem and construction of a detailed queueing model to obtain legitimate values. No time-motion studies, queueing model statistics, or other data base were found to provide for adequate analysis of this topic. However, believing that the need for HETs for this purpose is not zero and at least some vehicles will be waiting for parts or be in a repair queue at a maintenance unit, the following analysis was used to provide an initial estimate. At a minimum, it should highlight areas that need quantification.

a. Data. The only activity able to provide data related to the subject was the US Army Materiel Command (USAMC) Materiel Readiness Support Activity (MRSA) at Lexington, KY.

(1) Table 2-27 provides the work order data accumulated from January through July 1990 for three US DS activities in Europe and three in CONUS.

Table 2-27. Tracked Vehicle Maintenance Data

DS unit location	Total # maint actions completed	Mean time-to-repair excluding parts (manhours)	Mean turn-around time not awaiting parts (days)	# Maint actions awaiting parts	Mean turn-around time awaiting parts (days)
Germany	1522	6.4	9.7	411	20.6
"	1050	7.0	8.8	283	13.4
"	1116	10.2	15.6	316	18.3
	------			-----	
	3688			1010	
CONUS	966	3.7	15.9	261	19.6
"	388	4.0	12.4	91	16.8
"	288	1.3	18.8	63	21.4
	-----			-----	
	1642			415	

(2) The CONUS units exhibit the paradox that fewer mean time-to-repair manhours take a longer mean turnaround time and time to repair than that of the German-based US units. This is likely to reflect mission differences rather than a problem with the quality of personnel, poor facilities, or inadequate management in the CONUS units. The analysis below will consider only the German-based units.

b. Analysis

(1) Several adjustments to the peacetime data in Table 2-27 were made to better approximate wartime conditions.

(a) The number of maintenance actions awaiting parts is subtracted from the total number of maintenance actions to obtain the number of actions completed without parts delay.

(b) The time measuring instrument for mean turnaround time, the maintenance work order, runs continuously. To exclude weekends and holidays, the 9.7 days for the first unit in Table 2-27 should be reduced to 6.7 days (261 week days - 10 holidays = 251/365 = .69 X 9.7 = 6.7 days).

NOTE: a work order starts when the maintenance activity signs for the vehicle and ends when the owning unit accepts the vehicle after repair. Aside from weekends and holidays, mean turnaround time also includes time for work order rejection, customer notification, and customer acceptance (peacetime factors). Additional time can be explained by internal shop delays, for example, between maintenance and technical inspection or road tests (possible wartime factors). Still more time delay occurs because the vehicle must wait its turn in the maintenance queue prior to getting to the shop (definite wartime factor).

(c) Informal telephone discussions with maintenance personnel at Fort Carson, CO, indicated that the time between the initial technical inspection and maintenance, between the end of maintenance and the final technical inspection, and between final inspection and customer pickup would take 1 day each (3 days). The sense of urgency in war and reduction of procedural requirements associated with work orders could reasonably reduce the time in the shop by another day. Subtracting a full 4 days from the 6.7 days calculated in paragraph 2-13b(1)(b) above provides an optimistic total wartime mean turnaround time estimate of 2.7 days for the first unit located in Germany listed in Table 2-27.

(d) To correct for anticipated wartime double shift conditions versus the single peacetime 8-hour shift, an Ordnance School estimate of 7.3 available manhours/worker in each shift or 14.6 manhours/day reduces mean turnaround time by a factor of .55 (8/14.6 = .55 X 2.7 = 1.5 days).

(e) When parts are needed, the mean turnaround time is significantly longer. Again, to use the first unit as an example, the mean turnaround time (9.7 days) must be subtracted from the mean turnaround time awaiting parts to attain that period of delay attributable to parts (20.6 - 9.7 = 10.9 days). Repair time is then added to the parts time to get the total wartime maintenance turnaround estimate (10.9 + 1.5 = 12.4 days).

(f) It is difficult to assess whether the parts delay time of 10.4 days is appropriate for war using peacetime data. Higher wartime priority could reduce the delay significantly, at least until stocks are drawn down. It is also possible that HET requirements for maintenance unit moves could be reduced based on an aggressive evacuation policy. Fewer vehicles would be waiting in the queue when it became time to move the unit, but more vehicles would then be included in the maintenance evacuation requirements. An aggressive evacuation policy would use more HET assets because the movement of vehicles becomes more frequent (less probability of repair at the lower echelon) and that movement is probably over a greater distance.

(g) The fact that parts may be readily available from salvaged vehicles may be an advantage in reducing the "waiting for parts" time, but there is a penalty to be borne regarding the use of available manhours. The time necessary to take parts off a damaged vehicle would increase the mean-time-to-repair statistic. However, because no data exists on the time it takes to take the "average" part off a salvaged vehicle, no reduction in parts waiting time are included in this analysis. Table 2-28 shows the results of the above-mentioned adjustments for the three DS units located in Germany.

Table 2-28. Adjusted Tracked Vehicle Maintenance Data

Unit	Total # maint actions completed	Mean time-to-repair (manhours)	Mean turn-around time (days)	# Maint actions awaiting parts	Mean turn-around time awaiting parts (days)	Ratio parts vs maint vehicles
1	1111	6.4	1.5	411	12.4	3.05
2	767	7.0	1.2	283	5.8	1.78
3	800	10.2	3.7	316	6.4	.68
	2678			1010		

(2) The figures in Table 2-28 are sufficient to make some estimates for RAM repairable vehicles. First, about 27 percent of all RAM repairable vehicles will wait for parts (2678 + 1010 = 3688, 1010/3688 = .27). Second, given a flow of incoming repairable vehicles and outgoing repaired vehicles in equilibrium for the first unit, for every vehicle in maintenance there will be 3.06 vehicles awaiting parts at any point in time (411 X 12.4)/(1111 X 1.5) = 3.06. A weighted average for all units is 1.97 vehicles awaiting parts. Third, the maintenance queue for the first unit can be estimated by using the DS labor productivity factor of 7.3 hours per 12-hour shift (7.3 X 2 shifts = 14.6 X 1.5 days mean turnaround time = 21.9/6.4 mean time-to-repair = 3.42 vehicles in queue per vehicle in maintenance at any one point in time). The weighted average for all units is 3.72 vehicles.

(3) The next step is to determine how many vehicles are being repaired at any one particular time.

(a) The PFCAE-96 and PFASS Logistics Report is used to determine the number of vehicles in maintenance. This is the same file used to find the number of maintenance evacuations in the HET analysis and is based on AMSAA historical vehicle maintenance data. From Table 2-29, adjusting the 1027.26 vehicles repaired at DS in the 10 days of TP3 to a 4-day period gives 410.90 vehicles (1027.26 x .4).

(b) The weighted average for mean time-to-repair for the three DS organizations is 7.7 hours. Taking the DS figures as the average for the three maintenance levels, 7.6 vehicles could be repaired sequentially in any one maintenance bay for the 4 day period (4 days X 14.6 maint hrs/day = 58.4/7.7 average repair time = 7.6 vehicles repaired).

(c) Given that 410.90 vehicles from (a) above will be repaired at DS in the next 4 days, the minimum number of maintenance bays being used is 54.07 (410.90/7.6 vehicles repaired/maintenance bay = 54.07).

(d) The preceding logic disregards the possibility that maintenance capability may be greater or less than that needed to repair vehicles for any 4-day CEM period. It also does not account for the possibility that a crew may work simultaneously, not just one mechanic on a single vehicle. However, it does conform to the CEM presumption that all vehicles identified as having temporary damage (repairable) will be repaired by the end of the reporting period.

(4) The unit movement code for the unit maintenance section would be that of the parent unit. In LR1, the ETRANS values for frequency of movement would be 3 days for organizational maintenance units in a combat unit and 13 days for a divisional DS unit.

(5) A 12-hour warning appears reasonable prior to a maintenance unit move. A support unit may have several days' warning notice. It may be possible to repair a small number of vehicles. It is also possible to detour the transport of incoming damaged vehicles to the old unit location to the new location and thereby break the equilibrium flow of vehicles prior to the unit move. Reducing HET lift requirements derived by using the factors above by 25 percent to adjust for warning time yields the estimated requirement for HET lifts.

(6) Combat damage, having hidden and collateral damage in addition to that which is immediately obvious, is more pervasive and difficult to repair. The Ordnance School provided wartime DS tracked vehicle mean time-to- repair times in hours for inclusion into AFPDA as follows: tanks - 36, light armor - 8, and self-propelled (SP) artillery - 20. Because no average turnaround time values are available, the same factors determined for the RAM repairables, 1.97 vehicles waiting for parts and 3.72 vehicles in the maintenance queue, are used for each vehicle in maintenance. Treating combat damage in this fashion continues the conservative approach of this study.

(7) A microcomputer spreadsheet totaled all the vehicles in organizational, DS, and GS maintenance included in the CEM Logistics Report. The results provided in Table 2-29 are for 10-day TP. Field repair and CP maintenance are not included.

Table 2-29. Vehicles Repaired by Maintenance Level (PFASS\PFCAE-96)

TP	Organization	Direct support	General support
3	540.52 299.38	1027.26 461.50	105.48 61.26
4	781.44 604.58	1510.90 1040.90	144.87 125.86
5	1109.46 539.32	2033.30 846.12	197.04 104.22
6	1304.46 567.04	2289.34 806.96	216.76 101.50
7	1473.78 690.82	1973.72 856.56	188.02 113.84
8	1156.94 784.74	1682.44 1004.92	158.46 130.92
9	795.86 729.28	1057.72 845.80	104.08 113.48
10	607.18 671.96	712.84 745.36	71.12 100.24
11	469.90 661.24	487.86 741.36	48.80 98.20

(8) Calculating the number of HET lifts for a 4-day period of the 1027.26 vehicles repaired in TP3 at DS (1027.26 x 4 ÷ 10 = 410.9) is as follows:

```
            # vehicles for repair by DS in 4-day period = 410.90
               divide by # vehicles repaired in period: ÷   7.64
                                                        ------
                     total vehicles in shop at one time  =  53.78
      multiply by total vehicles waiting: 1.97 + 3.72 =  X  5.69
                                                        ------
     total vehicles needing movement at a point in time = 306.02
              divide by unit movement code (DS = 13)  ÷  13
                                                        ------
                        average # HET lifts per day  =  23.54
            reduced by 25% for advance warning time  = X   .75
                                                        ------
        HET requirements per day for unit moves for DS  = 17.655
                                         # days in TP = X 10
                                                        ------
                                                        176.55
```

c. **Estimate.** The values in Table 2-30 are derived by multiplying the total temporarily damaged vehicles repaired at organization, DS, and GS by the factors developed above.

Table 2-30. HET Lifts Supporting Unit Moves (PFASS\PFCAE-96)

TP	Organization	Direct support	General support	Total
3	402.56 223.24	176.55 79.30	8.12 4.74	587.24 307.28
4	581.96 450.24	259.68 178.90	11.16 9.66	852.80 638.80
5	826.34 401.66	349.46 145.44	15.16 8.02	1190.96 555.12
6	971.54 422.34	393.46 138.68	16.72 7.82	1381.72 568.84
7	936.18 514.54	339.24 147.22	14.46 8.76	1289.88 670.52
8	861.66 584.46	289.16 172.74	12.22 10.08	1163.04 767.28
9	592.70 543.12	181.78 145.38	8.04 8.74	782.52 697.24
10	452.18 500.48	122.54 128.10	5.48 7.70	580.20 636.28
11	349.96 492.48	83.82 127.44	3.84 7.54	437.62 627.46
Average workload	663.90 459.17	243.97 140.36	10.58 8.12	918.45 607.65

d. **Observation.** Data to support a queueing model which could better represent possible unit, DS, or GS wartime maintenance backlogs appears not to have been captured or developed to date. The wartime HET requirements estimate developed in this paragraph is believed to be low because of the conservative adjustments introduced to compensate for the use of peacetime data and the effects of unit movement warning time. As previously suggested, an analysis based on different parameters might produce lower HET requirements for maintenance unit moves *per se*. However, without analyzing the potential increases on HET maintenance evacuation requirements, the results may be specious.

2-14. TACTICAL RELOCATION (TRACKED VEHICLES)

a. Data

(1) This topic is not specifically retrograde in nature, but any requirement for the tactical relocation of tracked vehicles directly competes for HET assets that are primarily used for retrograde missions.

(2) Recent military experience (most notably in the Mid-East and Persian Gulf) has demonstrated the advantages of transporting tracked vehicles as far forward as possible and as quickly as possible to gain a tactical edge. The advantages of moving tracked vehicles for operational reasons include: a higher percentage of tanks and APCs available for employment, crew rest, less maintenance, less petroleum, oils, and lubricants (POL) and repair parts consumption, and more flexibility in developing the initiative.

(3) TRADOC has been recently studying HET use for operational purposes with the intent of incorporating the subject into doctrine.

b. Analysis

(1) The most recent acceptance of this concept by the TRADOC combat arms schools makes any statement in this study tentative at best. The impetus that the Saudi Arabia experience has given to this idea may increase the urgency to establish the requirements needed in each theater. The effects of the dense road network, high degree of rail HNS, and the relatively small distances in the Central Region may work to significantly reduce the need for HETs for this mission in Europe.

(2) All parties to the discussions appear to want to separate the mobility missions that may be developed from the evacuation missions currently used to justify the HETs. This may be a luxury not available, given the expense of procuring HETs. A corps heavy truck company should be able to perform both missions.

(3) Initial discussions concerning relocation of tracked vehicles differentiate between operational mobility, theater-level movements to effect a major influence, and tactical mobility movement within a corps area to support the corps commander's concept of the operation.

(4) Sizing the requirement for HET lifts range from 50 percent of the tracked vehicles for a division (operational mobility) to a battalion task force (tactical mobility) for the corps.

(5) Frequency of need for each type of relocation is not well-defined, but current thinking appears to indicate an infrequent need.

c. Estimate

(1) It is questionable whether this subject is appropriately included as a retrograde movement. Usually the movement would be lateral to the FEBA.

Moving 50 percent of the tracked vehicles in a division per day is a large number of lifts and may prove not to be feasible.

(2) For study purposes, inclusion of this topic is necessary because of the Saudi Arabian experience and recent TRADOC acceptance of the concept. Therefore, a daily theaterwide requirement to move a battalion task force in a single lift will be used as a baseline estimate.

2-15. CAPTURED ENEMY MATERIEL, DENIAL OPERATIONS, AND STRATEGIC MATERIALS. These possible retrograde missions were suggested in the RETRO II Study but were not pursued due to the lack of available information.

a. Data. All three categories were researched at HQ, US European Command (USEUCOM), HQ, USAREUR, and the 21st Theater Army Area Command (TAACOM) at Kaiserslautern, Germany. There is no evidence that these possible retrograde missions are considered in US planning.

b. Analysis

(1) Transportation movement control in the Central Region is the responsibility of specific commanders. The potential exists for US trucks or aircraft to be used in LR1 and 2 for captured enemy material. Requests for specific items would normally be included in operations orders. However, the RCZ and COMMZ areas are host nation controlled and enemy material would be transferred to HN control for further retrograde movement.

(2) Denial operations refer to the moving of critical plant, equipment, stockpiles, rolling stock, and other items deemed either of critical value to the war effort or items of distinct value to the enemy. The prevalent thinking in the European community is that the host nation would determine what is critical and be responsible for their movement. US vehicles would not be involved in denial operations.

(3) Strategic materials needed for the manufacture or operation of civil or defense equipment may not play an important role as in World War II; however, recovery of such materials would be necessary if directed. Such items would likely be started in US maintenance channels and be treated similar to cannibalized or recovered parts.

c. Conclusion. This is not a significant factor in retrograde transportation planning.

d. Observation. Even though US vehicles will probably not participate in these activities, some coordination/understanding with the host nation appears prudent. If HN concerns for specific items can be identified within the combat commander's movement control jurisdiction in advance (during peacetime), movement requirements can be deconflicted.

2-16. SUMMARY. This chapter quantified retrograde transportation requirements for personnel/cargo. Table 2-31 recapitulates the data discussed in paragraphs 2-4 through 2-15. The requirements are identified by LR and answer the question posed in EEA 1, what is the total retrograde transportation requirement for the NATO Central Region.

Table 2-31. Average Total Retrograde Requirements per Time Period for Personnel and Cargo (PFASS\PFCAE-96)

Mission	LR1		LR2		LR3-5	
	PAX	STON	PAX	STON	PAX	STON
EPW	60 60		62 58		62 58	
Medical	31,277 17,843		28,968 14,900		24,081 8,384	
NEO	N/A N/A		N/A N/A		(.5 - 1.3M) (.4 - 1.2M)	
KIA	7,601 3,709		75 62		N/A N/A	
Mail		98 111		111 79		61 48
Unit moves		113,000 89,800		178,000 56,500		84,000 0
Supply & ammo stocks		N/A N/A		33,533 16,333		96,800 0
Class VII & IX parts		5,123 6,361		0 0		879 362
Captured mat, denial opns, & strategic mat		N/A N/A		N/A N/A		N/A N/A
Total	38,938 21,612	118,221 96,272	29,105 15,020	211,714 72,833	24,143+NEO 8,442+NEO	181,925 600
HET lifts required						
Maintenance evacuation	2836.45 1546.67		206.11 64.89		0 0	
Unit moves (track veh)	907.87 599.53		0 0		10.58 8.12	
Tactical relocation	0 0		Unknown Unknown		0 0	
Total	3744.32 2146.20		206.11 + Tac rel 64.89 + Tac rel		10.58 8.12	

CHAPTER 3

RETROGRADE MISSION ANALYSIS

3-1. PURPOSE. To determine the type and amount of transportation force structure needed to satisfy the retrograde transportation requirements identified in Chapter 2. The force structure needed or that may be available to satisfy forward-moving requirements is not considered. Requirements for truck companies will be estimated and compared for the two European scenarios, PFCAL-96 and PFASS.

3-2. INTRODUCTION. This chapter analyzes the workload identified in Chapter 2 and determines the best transportation response for the missions listed in paragraph 3-3. In keeping with the desire not to overstate retrograde requirements, most of the workloads have been averaged, which serves to understate peak needs. **Note:** as discussed earlier, current transportation force structure policy is implemented in the FASTALS Model for calculation. In this chapter, "FASTALS-generated" or "in FASTALS" implies current transportation force structure policy.

a. For each retrograde mission, the transport requirement developed in Chapter 2 is restated, an analysis from a transportation viewpoint is developed, a result regarding the need for transport resources is stated, and observations, if any, are provided. If the workload is judged to be significant, the number of truck companies needed to satisfy the requirement, independent of all other factors, will be calculated. Various conditions of a particular variable that determined the workload may be analyzed as a sensitivity comparison. Alternative viewpoints of interpreting the data are mentioned when results could be significantly different.

b. Transportation truck companies referenced in this chapter are categorized in terms of either light (cargo capacity of 5 tons or less) or medium (all other trucks and tractor-trailers having a capacity of up to 34 tons). Heavy trucks, such as the HETs, are examined in detail in Chapter 5, but some results are included in this chapter for completeness.

(1) The Light Truck Company, TOE 55718L200, contains 60 5-ton trucks and is allocated by FASTALS-generated workloads of Class IX and general supplies in LR2-4. The company can transport 900 STON/day or 3,600 PAX for local haul, or 450 STON or 1,620 PAX for line haul. In general, the FASTALS workloads generate few light truck companies.

(2) The Light-Medium Truck Company, TOE 55719L100, contains 50 5-ton trucks and 10 5-ton tractors with 25 22.5-ton trailers. The 5-ton trucks are capable of transporting 375 STON/day and the tractor-trailers can transport 225 STON/day on line hauls. These figures double for local hauls. One company is allocated to the corps for each division support command within the corps. The company is usually in the corps forward and available to support a specific division but also can be used to support adjacent divisions.

(3) There are two types of medium truck companies.

(a) TOE 55727L100 has 60 tractors and 120 trailers. Each trailer is 40 feet long and estimated to have an average cargo capability of 22 STON or one 40-foot container or two 20-foot containers. With 75 percent of the vehicles available, daily capability is 3,960 STON for local haul or 1,980 STON for line haul. FASTALS allocates this unit to COMMZ transportation units based on the accumulations of Workload 18.

(b) TOE 55728L100 has 60 tractors and 150 trailers. Each trailer is 28 feet long and estimated to have an average cargo capability of 15 STON or one 20-foot container. With 75 percent of the vehicles available, daily unit capability is 2,700 STON for local haul or 1,350 STON for line haul. FASTALS allocates this unit to corps transport units based on the accumulations of Workload 18.

3-3. RETROGRADE MISSIONS. The retrograde missions discussed and listed (Table 3-1) in this chapter follow the sequence established in Chapter 2.

Table 3-1. Retrograde Missions

Paragraph	Mission	Transportation truck company
3-4	Enemy Prisoners of War (EPW)	Light
3-5	Medical Evacuation	Light
3-6	Noncombatant Evacuation Order (NEO)	Light
3-7	Killed in Action (KIA)	Light/Medium
3-8	Mail Transport	Light/Medium
3-9	Unit Moves (except tracked vehicles)	Medium
3-10	Supply and Ammunition Stocks	Medium
3-11	Class VII and IX Parts	Medium
3-12	Maintenance Evacuation	Heavy
3-13	Unit Moves (tracked vehicles)	Heavy
3-14	Tactical Relocation (tracked vehicles)	Heavy
3-15	Captured Enemy Materiel	All
3-15	Denial Operations	All
3-15	Strategic Materials	All

3-4. ENEMY PRISONERS OF WAR (EPW). Table 3-2 reflects workload data developed in Chapter 2.

Table 3-2. Average EPW Transportation Workload/Day

LR	TP	PFCAE-96	PFASS
Within LR1	3-11	53.9	64.9
LR1 to LR2	4-11	60.0	60.0
LR2 to LR4	5-11	62.1	57.8
LR4 to APOD	5-11	62.1	57.8

a. Evaluation

(1) The data in Chapter 2, Table 2-2, indicate that it takes up to 20 days for an EPW to arrive in LR4 for incarceration or air evacuation (more that 20 days in the case of the PFCAE-96 EPWs taken in TP2). Figure 2-1, Chapter 2, demonstrates how the daily average flow is modeled between LR1, 2, and 4 for TP2 through TP6. The interpretation is that EPWs captured during TP2 and TP3 do not arrive at LR4 until TP5. Similar EPW flow continues for TP7 through 11 and also for the PFASS flow.

(2) Some EPW will be wounded, injured, or sick and would go to hospitals designated to care for EPWs for treatment. This would place an added burden on the manner and destination of transport requirements, to include the medical transport system. A commonly accepted factor for EPW patients is .067/1000 of FASTALS Workload 15, Enemy Prisoners of War. Neither scenario generated enough EPWs to justify identification of a separate hospital.

(3) Informal contact with representatives of the Military Police School Combat Development Office indicates that EPWs are to be evacuated toward LR4 in the minimum time possible consistent with intelligence requirements. Generally, EPWs should be moved from the division within 12 hours and from the corps within 24 hours. The military police are responsible for EPW movement but have no control of the transportation resources used for EPW transportation. In LR1, requests to transport EPWs are forwarded to the division transportation officer for execution. While dedicating a vehicle for this mission is possible, using this mission as a backhaul opportunity is both reasonable and expected. Table 3-3 provides guidelines used by the Military Police School to judge the number of vehicles needed to transport EPWs.

Table 3-3. Vehicle Requirements for Escort of EPWs

Light vehicles		
	1 1/4-ton truck (CUCV)	9 captives/2 guards
	1 1/4-ton truck (HMMWV)	9 captives/2 guards
	2 1/2-ton truck	20 captives/2 guards
	5-ton truck (M900 series)	20 captives/2 guards
	5-ton truck (M200 series)	20 captives/2 guards
Medium vehicles		
	6-ton semitrailer	24 captives/2 guards
	10- or 12-ton semitrailer	50 captives/4 guards
	Passenger bus	37 captives/3 guards
Rail cars		
	Boxcar	22 captives/3 guards
	Passenger car	34 captives/6 guards

(4) Transport of EPWs within the division area could normally be done with a single sortie using any light vehicle listed in Table 3-3. The distances from battalion and brigade to division are short. It is not unreasonable to road march prisoners to the division EPW holding area. Unit vehicles are not counted in retrograde transportation considerations because first, they are not workload-generated, and second, the unit vehicles are allocated based on missions that support the unit, e.g., EPW transport.

(5) For the four-corps theater structure in PFCAE-96, the numbers in Table 3-2 suggest that all the divisions and separate brigades in a single US corps combined would average less than 15 EPWs needing transport to the corps holding area per day. On average, a single 2 1/2 or 5-ton truck sortie per day would suffice. The three corps in the PFASS scenario have a slightly higher EPW capture rate; therefore, a second sortie would be needed more often when the rate is higher than average. If backhaul vehicles were unavailable, a vehicle would normally be supplied by the division light-medium truck company. Result: not more than four local haul sorties/day by corps vehicles originating in LR1 for either scenario (.03 TOE 55719L100) (4/(50 trucks X .75 availability = 37.5 X 4 local hauls/day/truck co = 150) = .266). This does not conform to Desert Storm experience but is in keeping with the scenarios used for this study.

(6) Trucks or HN buses and rail may be used for transporting EPWs between corps and the COMMZ. Generally, the responsibility for EPWs is not exchanged between countries (again, Desert Storm is an exception). EPWs being transported by HN assets are still under the control of US authorities. US transportation doctrine does not employ medium trucks to transport passengers unless an emergency exists. If distances are long, the use of light trucks to the corps railhead is

reasonable. Each corps would need a single light truck sortie per day to the origin railhead in LR2. At the destination railhead in LR4, either local hauls by four trucks or two HN buses are needed for EPW transport to the internment camp. Result: four local haul sorties/day by corps trucks in LR2 and four local haul sorties in LR4 for both scenarios (.03 TOE 55719L100 in LR2 and TOE 55718L200 in LR4).

(7) Eventually, EPWs are to be evacuated to overseas locations. The EPW camps are generally constructed near an APOE for ease of transfer to aircraft. HN assets will be used between the internment camps and the APOE. Result: .03 TOE 55718L200 in LR4.

(8) The movement of the camps is a distinct possibility in the PFCAE-96 scenario and also would be done by HN support. The transport requirements for the relocation of the camps are included in paragraph 3-9.

b. Conclusion. The difference between PFCAE-96 and PFASS EPW operations is not significant. EPWs are easily and quickly loaded and unloaded, and EPW missions are easily integrated with forward missions for light trucks. Without considering the backhaul potential, a maximum 10-day average of three light trucks/day is needed for the theater.

c. Observation. FASTALS modeling of the evacuation of EPWs appears not to follow the Military Police School doctrinal concept and USAREUR policy of quickly moving prisoners from forward areas to LR4. In addition, FASTALS does not accommodate the USAREUR policy of moving EPWs out of the Central Region (i.e., to CONUS).

3-5. MEDICAL EVACUATION. The two sources of medical patients are routine evacuation of patients and the movement of patients due to the relocation of hospital facilities. Table 3-4 shows the total workload by TP. Total workload is used instead of an average workload for all TP because the retrograde analysis centers on the number of patients that the medical transport system is not able to move; therefore, only the transport for the patient overflow will necessarily depend on the common user system.

Table 3-4. Total Medical Evacuation Workload (000) (PFASS\PFCAE-96)

	Time period								
	3	4	5	6	7	8	9	10	11
Total workload	44.5	83.9	12.21	29.11	84.1	51.9	96.5	84.5	81.2
	17.8	38.8	42.7	43.4	48.7	49.8	44.9	41.9	42.3

a. Resources/Capability

(1) The medical community has had the long-standing policy of justifying vehicles and aircraft to support their evacuation operations independent of the common user transportation system. Even so, planners at

the Academy of Health Sciences recognize that common user transportation resources will need to provide backup support. For example, common user transport could be appropriate when a hospital, due to battle damage, had to be quickly evacuated if it were in imminent threat of ground attack, or in instances involving mass casualties. Past REFORGER exercises have included simulation of common user resources for patient evacuation. Central Europe also has host nation ambulance trains that may be available from the corps rear to the COMMZ.

(2) Medical ambulance services are of two types: air ambulance (SRC (standard requirement code) 08447L200) or ground ambulance (SRC 08449L000). A ground ambulance company can transport any combination of up to 160 litter or up to 320 ambulatory patients in a single lift. The air ambulance company can fly any combination of up to 60 litter or 105 ambulatory patients. Unlike hospitals which are allocated on the basis of actual or anticipated patients, ambulance companies are allocated based on the existence of combat units or the size of the COMMZ. Some US military communities may have buses which have litter conversion kits that are assigned to hospitals and could provide additional ground ambulance capability during the community transition to war. This bus capability could be used as an offset against host nation support.

(3) Table 3-5 lists the number of ambulance companies that FASTALS generates as a result of program inputs available for both scenarios. There are no ambulance companies in LRs other than those shown. LR4 ground ambulance companies are shown as the number of US and HN companies.

Table 3-5. Ambulance Companies (PFASS\PFCAE-96)

TP	3	4	5	6	7	8	9-11
LR2 Air	14	15	16	22	22	22	22
	15	15	15	20	24	24	24
Ground	10	13	15	21	24	25	26
	11	11	11	15	18	18	18
LR4 Air	2	------>					2
	3	------>					3
Ground	3+15	------>					3+15
	0+15	------>					0+15

b. Analysis

(1) The total single lift capability of ambulance companies is computed by multiplying the number of air or ground ambulance companies by the litter/ambulatory potential as stated in paragraph 3-5a(2) above. It is difficult to find an authoritative source to estimate the number of sorties that the ambulance companies can perform in a day. Factors such as weather, distances, road conditions, and enemy air activity will determine the effectiveness of the helicopters and vehicles.

(2) For study purposes, the ambulance companies will be workloaded as if they were standard transportation units. A 75 percent availability factor for aircraft and 80 percent availability factor for ground ambulances will be assumed. Each available aircraft and vehicle is capable of four sorties/day within LR1 and between LR1 and LR2 (local haul) and two sorties/day from LR2 to LR4 and within LR4 (line haul). Assume that litter patients will constitute 80 percent of the total in LR2 and 50 percent in LR4. Further, a factor of 60 percent of capacity will be used for LR2 ambulance units and 80 percent for LR4 units. For example, the first number in Table 3-6, 1.74 thousand patients using LR2 local haul air sorties, is calculated as follows:

```
For litter patients:

 possible litters/sortie/co =  60
                              X 75% availability
                              ------
                                45  available litters/sortie/co
litter patient factor for LR2 X 80%
                              ------
                                36  litter patients transported/sortie
      local haul multiplier   X  4
                              ------
                               144  litter patients transported/day/co
PLUS:  for ambulatory patients:

  ambulatory spaces/sortie/co = 105
                              X 75% availability
                              ------
                                78.8 available ambulatory spaces/sortie/co
      ambulatory multiplier   X 20%
                              ------
                                15.8 ambulatory patients transported/sortie
    local haul factor for LR2 X  4
                              ------
                                63  ambulatory patients transported/day/co
```

Total: (144 litter + 63 ambulatory) X 60 percent capacity = 124.2 patients/day/co X 14 air ambulance cos = 1,739 patients by air in LR2 and shown as 1.74 thousand in Table 3-6.

Table 3-6. Daily Patient Evacuation Capability (000) (PFASS\PFCAE-96)

Ambulance mode	Time period 3	4	5	6	7	8	9-11
LR2 Air-4 sorties	1.74	1.86	1.99	2.73	2.73	2.73	2.73
	1.86	1.86	1.86	2.48	2.98	2.98	2.98
Ground-4 sorties	3.84	4.99	5.76	8.06	9.22	9.60	9.84
	4.22	4.22	4.22	5.76	6.91	6.91	6.91
LR4 Air-2 sorties	.20	--------->					.20
	.30	--------->					.30
Ground-2 sorties	5.99	--------->					4.99
	4.99	--------->					4.99
10-day Total	117.7	130.4	139.4	169.8	181.4	185.2	187.6
	113.7	113.7	113.7	135.3	151.8	151.8	151.8

c. **Conclusion.** Figure 3-1 portrays the relationship between the total patient flow to the total ambulance capability in the theater by TP based on the workload assumptions stated above. An excess of ambulance capacity exists in each scenario for all TPs. PFASS, in particular, is overstructured by a factor of more than 2.5. Result: there is no reason to believe that common user transportation is needed to transport patients; therefore, no force structure is justified.

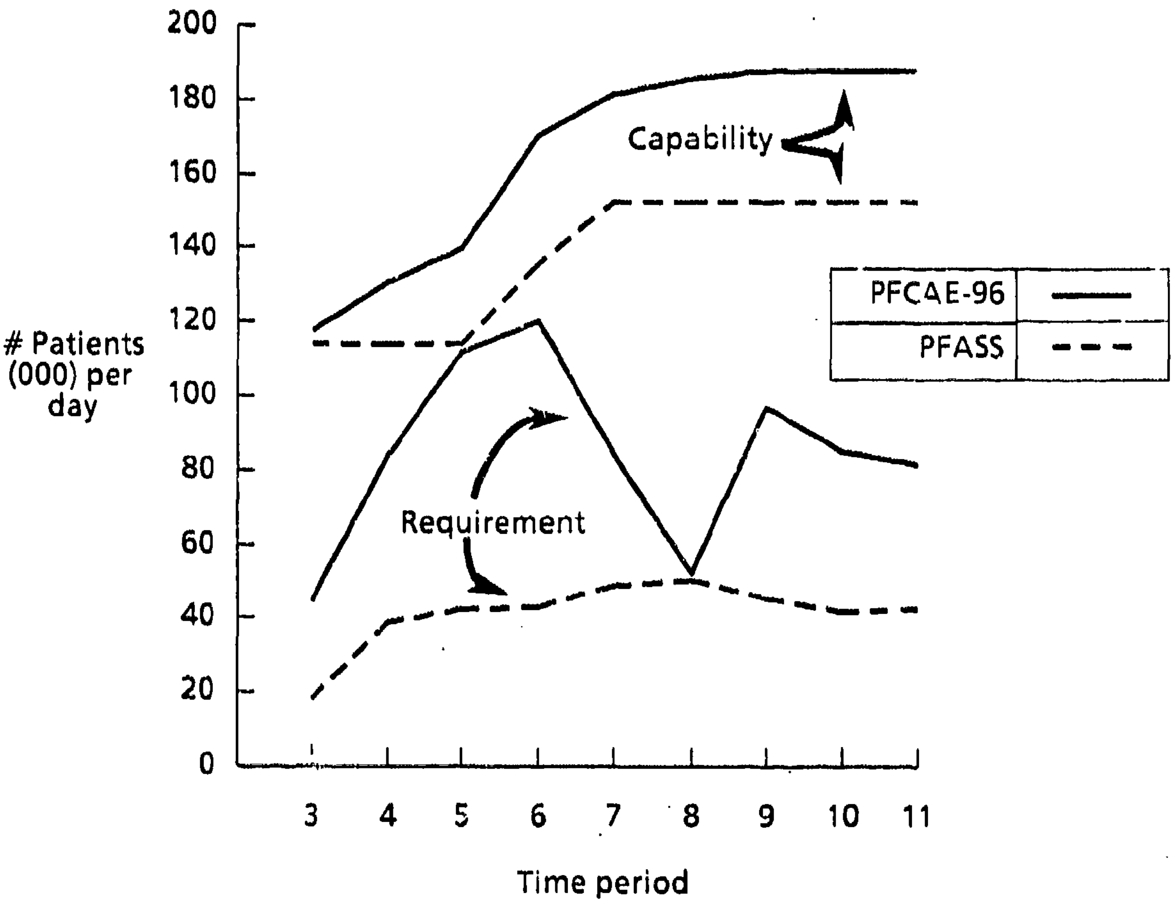

Figure 3-1. Patient Flow vs Estimated Ambulance Capability

d. Observations

(1) The ambulance company capability statement in the TOE is difficult to apply and should be stated in units of transport capability, e.g., "total patients per day," and not in terms of single lift capability.

(2) Combat development personnel at the Transportation School believe that patient transport is a viable mission for the common user transportation system. The medical establishment argues to the contrary, citing the need for providing medical care while patients are being transported, need for transport to be immediately available, and that special markings are required for medical vehicles.

3-6. NONCOMBATANT EVACUATION ORDER (NEO). The PFCAE-96 workload of .5 to 1.3 million personnel in LR3-4 is an informal undocumented estimate provided by Department of the Army, Office of the Deputy Chief of Staff for Personnel. The workload reduction by 100,000 for PFASS is based solely on the lower number of dependents and support personnel needed for the post-CFE US military mission. No workload is anticipated to originate in other LRs.

a. Resources/Capability

(1) The priority for backhaul air transport of personnel to the US is wounded, NEO, and then EPWs.

(2) Two transport alternatives are available for NEO personnel--either direct transportation to the US or surface passage to a temporary "safe haven" prior to going to the US.

(3) USAREUR war plans provide for NEO movement to the APOE. There appears to be no set schedule for theater evacuation. One measure available in FASTALS output data to estimate the potential to move NEO from APOE (incomplete at best) is FASTALS Workload 19, Replacements through Replacement Camps. This figure counts only Army personnel. Multiplying by 150 percent may adequately compensate for other US service and civilian personnel coming into the Central Region. Given the minimum estimate of 500,000 evacuees, Figure 3-2 shows the anticipated relationship between the adjusted Workload 19 figures and the remaining NEO population awaiting evacuation. Both the NEO and Workload 19 figures are considered conservative and provide an estimate on the lower end of actual expectation. The effect of adding the priority evacuation of wounded shifts the NEO curves to the right.

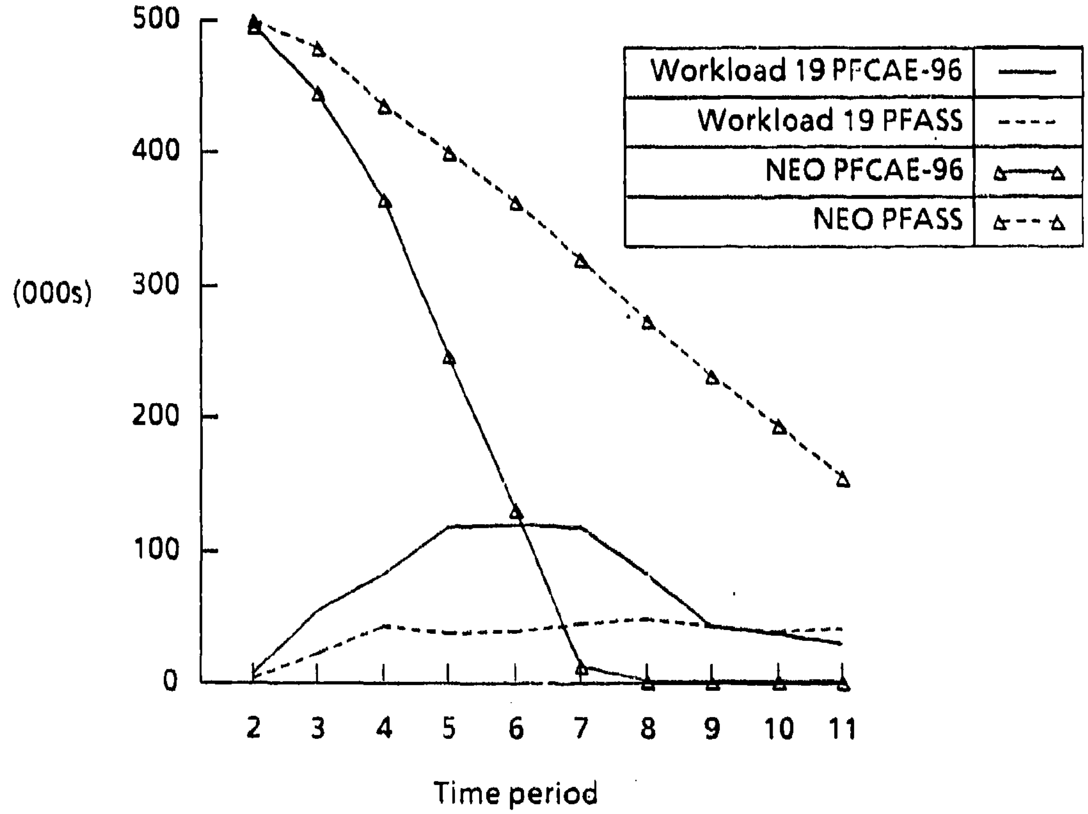

Figure 3-2. NEO Evacuation Potential Based on Replacement Estimates

b. Analysis

(1) USAREUR NEO planners appear to make a distinction between DOD sponsored and non-DOD sponsored NEO participants.

(a) DOD sponsored participants are included in formal military community war plans, aware of their obligations through classes and practice, usually cognizant of the military situation, and transportation resourced by private, US, or the HN for travel to a RCZ/COMMZ destination. Another advantage is that DOD-sponsored personnel are located on or near US bases.

(b) Most non-DOD sponsored people have none of those advantages. They may not receive State Department warnings in a timely manner, may not have resources to participate in a local NEO program, or know where or how to take advantage of evacuation arrangements made by either the State Department or USAREUR.

(c) A NEO participant who makes a belated effort to exit the Central Region may encounter American military communities that are no longer functioning. Tourists and businessmen may not be near US forces installations during peacetime or US battlefield sectors during wartime. This may pose problems for US forces operating in a Northern Army Group, Central Europe (NORTHAG) region that did not have peacetime cantonment areas or well-rehearsed NEO plans. Limited relief may be afforded by bilateral agreements with allied nations operating in the NORTHAG area.

(d) The fact that all NEO participants will start from a date determined by the State Department (the evacuation declaration is not a theater or Defense Department decision) allows all participants to start evacuation at the same time. Even so, the relative advantage of DOD participants may allow most to depart the theater prior to D-day. Figure 3-3 provides a conceptual view of the relationship between DOD and non-DOD NEO participants desiring to depart the theater.

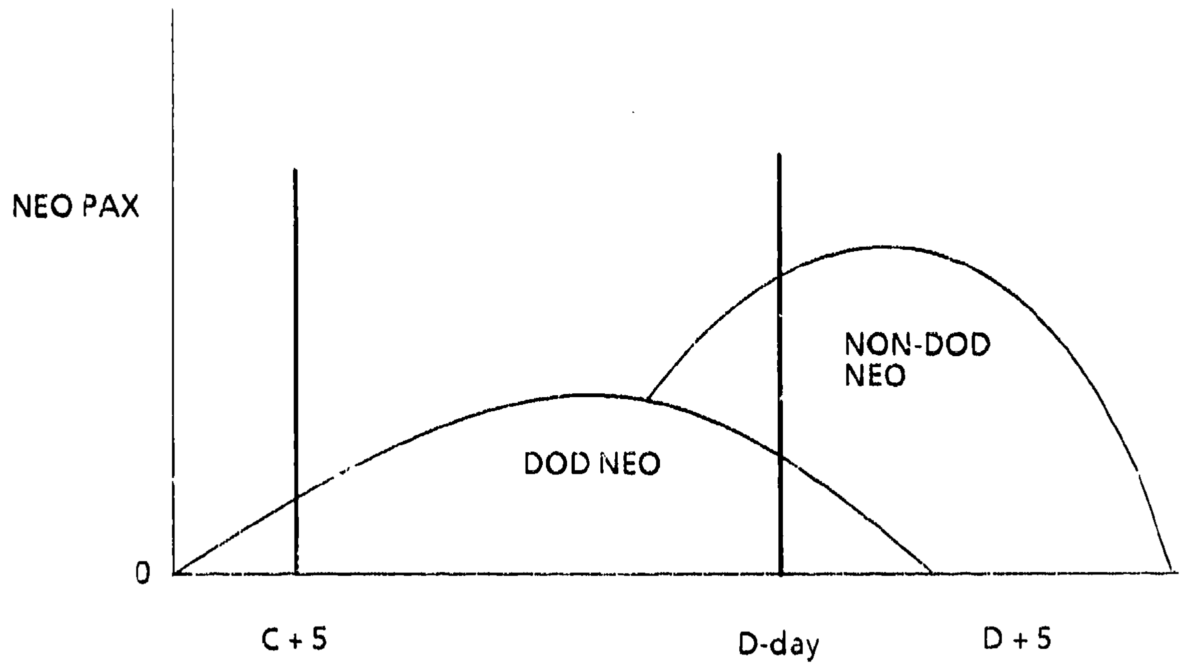

Figure 3-3. Conceptual Relationship of Evacuation Time between DOD and Non-DOD NEO Participants

(2) It is evident from the concept depicted by Figures 3-2 and 3-3, particularly in PFASS, that NEO participants may have to remain at the APOE for lengthy periods prior to being airlifted to CONUS. Most PFCAE-96 APOEs would be endangered or overrun prior to the completion of evacuation. Given the parameters of the above analysis, it is evident that the host nation will be asked to transport Americans to safety elsewhere in the theater by surface means.

(3) USAREUR can be expected to be charged with executing non-DOD NEO evacuation either before or after hostilities start. NEO participants will be staged in the local area of APODs until evacuated or will travel by land, sea, or air to safe havens. Travel to APOEs, safe havens, or water ports will be by HN bus and rail. No war plan or study available for review provided assurance that adequate planning has been done to accommodate NEO evacuation. The PFASS scenario can be expected to have more non-DOD-sponsored NEO eligibles in the eastern part of Germany, which may be more difficult to evacuate. Anticipated NEO disposition is as follows:

(a) Prior to D-day

1. DOD-sponsored: travel to designated APOE using nontactical vehicles as directed by the US military community NEO plan. Some NEO personnel will be evacuated by air, others transported to safe havens within the theater.

2. Non-DOD-sponsored: as determined by the State Department and implemented by local US community or military personnel officials. Tactical vehicles will not be available for community use. No reference has been found on what NEO eligibles should do if they are enveloped in a hostile or prehostile environment. For example, what instructions from the local German authorities should be followed and what political rights should non-DOD personnel expect or be denied.

(b) Post-D-day

1. DOD-sponsored: local travel to APOE, seaport of embarkation (SPOE), or safe haven by nontactical vehicle, privately owned vehicle, and HN bus or rail.

2. Non-DOD-sponsored: travel to APOE, SPOE, or safe haven per guidance of the State Department. Transfer to military control when practical. Tactical vehicles may be used incidental to travel in isolated instances but are not dedicated for this purpose.

(4) Several factors mitigate the possibility of significant numbers of NEO eligibles being caught in LR1 and 2. First, the German government's preparation of their citizenry for possible conflict is thought to be well planned. Second, commercial activity would be restricted. Third, the host nation civil affairs cadre may have specific instructions and resources for evacuating (or detaining) non-German citizens. This results in no measurable NEO requirements in LR1 and 2.

(5) Reliance on the host nation to transport NEO eligibles in LR3-5 is high, and the workload is large. There is no reason to believe that tactical vehicles will be used. Given a specific set of circumstances, an HNS workload can be estimated.

(a) The minimum NEO estimate is .5 million. Evacuation from the theater within 30 days, i.e., from TP2 through TP4, is a reasonable objective. Most NEO eligibles should be able to arrive at the designated marshalling location using the local community NEO plan prior to the outbreak of hostilities. Using the same assumptions as in paragraph 3-6a(3) above,

very close to 50 percent of the people in the PFCAE-96 scenario will be able to fly from an APOE to CONUS in the 30-day period from TP3-5. The remainder will use rail to get to a safe haven.

(b) A daily average of 8,333 people will need HN buses for transport to the APOE. At 50 people per bus and 4 sorties/day/bus, a total of 42 buses will be required each day. The equivalent resources in terms of truck companies is 2.31 light truck companies, TOE 55718L200 (8,333/20 PAX/4 sorties per day).

(c) The remaining 50 percent will need an additional 42 buses for transport from the marshalling area to the rail station. At 50 people per rail car and 1 sortie/day/rail car, 167 rail cars per day (approximately 17 trains) will be needed to transport NEO participants to safe havens. Again, 2.31 light truck companies will be needed.

(d) As shown in Figure 3-2, the PFASS NEO evacuees will rely predominantly on rail transport because Workload 19 indicates that far fewer aircraft may be arriving from CONUS. The 400,000 NEO people will need the equivalent of 3.70 light truck companies of HNS each day for 30 days (400,000/30 days/20 PAX/4 sorties/45 trucks per company).

(e) No further analysis will be done on this aspect of NEO support because it is doubtful that the US would plan additional force structure for an identified shortfall.

c. Conclusion. It is difficult to foresee other than incidental use of tactical vehicles for NEO evacuation. Gauging the time and degree of HNS required is difficult because of the size and range of the estimated workload. This results in no measurable tactical force structure used for this purpose.

3-7. KILLED IN ACTION (KIA). This category includes US servicemen that are deceased as a result of all causes in the Central Region. More than 90 percent of all PFCAE-96 and 84 percent of the PFASS KIA are generated in LR1. Table 3-7 summarizes the workload calculated for LR1 in Chapter 2.

Table 3-7. KIA (PFASS\PFCAE-96)

Time period 3	4	5	6	7	8	9	10	11
6,431	11,057	16,182	14,333	10,017	4,556	2,851	1,982	1,003
1,877	4,566	3,744	4,625	4,204	4,523	3,526	3,017	3,302

a. **Resources/Capability**

(1) Personnel remains will be treated with respect. Under normal circumstances, the dead will be put in body bags as soon as possible and transported in the cargo area of light or medium trucks in a single layer. The M35A1, a typical light truck, has a cargo area of 84.3 square feet. At 7 square feet each, a light truck could transport 12 body bags, while a medium tractor-trailer found at corps with a 28-foot trailer has 223.3 square feet and could carry 32 bodies.

(2) Other means of evacuation of remains are available and may be used as their availability permits. A higher priority for aircraft is the evacuation of wounded. US Army Combined Arms Support Command (CASCOM) staff officers offered an unofficial estimate that 10 percent of remains in the Central Region may be evacuated by air. HN rail from the corps rear back to the COMMZ may be used, although no host nation agreements specifically provide for HN support of KIA. An escort may be necessary to ensure delivery to the proper destination. Red Cross and hospital/medical assets are not normally used for this purpose.

(3) Remains are normally covered when possible. Covered vans, 20-foot and 40-foot containers, or tarpaulins prevent viewing of body bags. Reconverting a truck or trailer may take some time, but loading/unloading the bodies should be quick.

b. **Analysis**

(1) Unit commanders are responsible for burying the dead when and where necessary if no other recourse is available. However, the commander's responsibility is to recover and transport remains to the nearest graves registration team. A unit vehicle or a vehicle from division will perform transport within LR1 to the division collection point. For study purposes, a unit vehicle will transport the bodies 60 percent of the time. (Unit vehicles are not counted in FASTALS force structure calculations.) The division will use a light vehicle 40 percent of the time that is loaded to an average 50 percent of capacity. All LR1 transport is local haul.

(2) From the division collection point, medium trucks will evacuate deceased directly (line haul) to the theater mortuary. A 70 percent load factor seems reasonable.

(3) Quicker disposition (e.g., temporary burial) is dictated during hot weather, since less time is available before decomposition starts and a health hazard exists. During intense fighting, temporary graves may be used in forward areas until the proper arrangements can be made.

(4) Remains have no priority for transportation to CONUS. Cargo, NEO, medical evacuation, and EPW evacuation may make it impossible to transport all US dead back to the US for burial in a timely manner. For study purposes, all KIA will be evacuated by truck to LR4 for temporary burial in a theater cemetery. Transport requirements from the theater mortuary to the APOE are uncounted.

(5) Using the KIA workload and the assumptions cited above, the number of truck companies needed per TP is shown in Table 3-8. The first number of the result (i.e., .24/.28), is the number of light truck companies and the second number represents medium truck companies. The PFCAE-96 number for TP3 was calculated as follows:

KIA in TP3 =	6,431	
	÷ 6	bodies/lt truck (50% load factor)
total lt truck sorties =	1,071.8	
	÷ 4	2 shifts, local haul multiplier
total lt trucks required	268.0	
	X 40%	nonunit truck factor
total nonunit support trucks/TP =	107.2	
	÷ 450	lt truck days/TP/co(75% available)
total lt truck companies/day =	.24	within LR 1
PLUS:		
number of KIA in TP3 =	6,431	
	÷ 25.6	bodies/med truck (80% load factor)
total med truck sorties =	251	
	÷ 2	2 shifts, line haul multiplier
total med trucks required =	125.6	
	÷ 450	med truck days/TP/co (75% avail)
total med truck companies/day =	.28	from LR2 to theater mortuary

Table 3-8. Light and Medium Truck Companies/Day for KIA (PFASS\PFCAE-96)

Time period 3	4	5	6	7	8	9	10	11
.24/.28	.42/.48	.60/.70	.53/.62	.37/.44	.17/.20	.11/.12	.08/.09	.04/.04
.07/.08	.17/.20	.14/.16	.17/.20	.16/.18	.17/.20	.13/.15	.11/.13	.15/.17

(6) Result: the average values for light-medium truck companies (TOE 55719L100) and medium truck companies (TOE 55728L100) for PFCAE-96 are .29 and .35, respectively. The average values for PFASS are .15 light-medium truck companies and .17 medium truck companies per day.

(7) The number of KIA in LR 2-5 is relatively small and spread over a wide area. It is likely that unit vehicles will provide the majority of the transportation to the theater mortuary. In cases where there is a concentration of remains, corps and theater trucks may be used, but the effect on the truck units primary mission requirements should be negligible.

c. Conclusion. A small but measurable number of trucks is needed for retrograde of KIA. Air transport may reduce the requirement by a small amount, while deceased from non-LR1 units and hospitals will increase the requirement for LR2 through 5 marginally. Rail is expected to play a minimal role as additional handling is needed for transfer between truck and rail. Unnecessary handling or viewing of remains should be minimized, since it is considered detrimental to morale.

d. Comments. The transportation estimate for KIA excludes a factor for non-Army pilots, allied soldiers, enemy dead, and others found on the battlefield. The ability of the host nation to transport Army dead along with their soldiers and noncombatants killed in the conflict is not addressed. The effects of the German "stay put" policy may affect KIA transport assets if civilian casualties are heavy in US sectors.

3-8. MAIL. The average daily workload for the Central Region is shown in Table 3-9. Workloads developed for TPs in Chapter 2 have been divided by 10 to derive daily figures.

Table 3-9. Average Daily Retrograde Mail by Origin LR (STON) (PFASS\PFCAE-96)

	LR1	LR2	LR3	LR4	Total
Average workload	9.76 11.08	8.72 7.88	2.36 1.92	3 78 2.88	24.62 23.76

a. Analysis

(1) The FASTALS program does not include mail moving from the theater toward LR1 as a workload counter. The volume of mail moving forward most likely exceeds the volume moving in retrograde. That certainly appears true, judging from the comments made by newscasters and magazines covering operation Desert Shield of large tonnages of mail that needed movement.

(2) Peacetime mail transport in Europe is done using a Standard Transportation Request. This procedure effectively provides the requirement for the type vehicle that conforms to postal security regulations traveling a specific route on a daily basis. Use of locked vans and custodial requirements (either a US driver or guard) may have to be suspended during war. Generally, mail trucks will ply between postal facilities, and trailer transfer points (TTPs) normally used as way stations for cargo will not be used. Mail is generated daily. Its importance to morale makes it reasonable to believe that trucks for mail transport will be a daily retrograde requirement in all LRs.

(3) Mail tonnage is cumulative, that is, division mail becomes a transportation workload in LR2, and LR1 and 2 mail is added to RCZ and COMMZ mail until it leaves the theater APOE. Packages may go to an SPOE.

(a) The divisions, separate brigades, and cavalry in LR1 for the four corps in PFCAE generate an average of 2.44 tons/corps (9.76/4 corps). That approximates to 1/2 ton per each division plus 1/2 ton for all other forward units of the corps. The three PFASS corps average 3.70 tons per day which is approximately 3/4 of a ton/day for each division and 3/4 ton for all other forward units. Unit vehicles can be expected to bring mail to a division or separate brigade postal facility.

(b) If the Standard Transportation Requests used during peacetime are not continued, tactical or HN trucks will be used. Light trucks from the light-medium truck company could be used to pick up mail from all the division and other unit postal facilities each day for delivery to the corps postal facility which may be a considerable distance back into the corps. However, it is reasonable to believe that the same trucks that pick up retrograde mail will also deliver mail, probably in even greater volumes. Loading and unloading delays for each truck at several pickup points will reduce road time. Result: eight light truck (TOE 55719L100) line haul sorties/day for PFCAE-96; six for PFASS.

(c) Mail generated in corps units also has to get to the corps postal facility. Considering the mail weight, large geographical size of a corps, slow speed (12 miles per hour (MPH)), and pickup/delivery delays, an estimate equal to that of the division requirement is reasonable. Result: eight light truck (TOE 55719L100) line haul sorties/day for PFCAE-96; six for PFASS.

(d) Approximately 20 tons of mail goes from LR2 to LR3 and from LR3 to LR4. A corps medium truck can transport 15 STON and a theater medium truck can haul 22.5 STON. Result: two medium truck (corps) and two medium truck (theater) line haul sorties/day for both PFCAE-96 and PFASS.

(e) LR3 and LR4 units are spread over a large territory, making it difficult to break the workload into subunits for analysis. However, an estimate that a light truck can pick up 1 ton of mail from several small postal facilities in the RCZ/COMMZ in a 12-hour period seems reasonable. Result: seven light truck (TOE 55718L100) line haul sorties/day for PFCAE-96; five for PFASS.

(f) Most retrograde mail will be flown to CONUS and the remainder will go by sealift. Trucks will have to be used between the theater postal facility and the APOE (local haul) and the SPOE (line haul). Result: six light truck local haul sorties/day and one medium truck line haul/day for each scenario.

b. Conclusion. Differences in quantities of retrograde mail or the method of transport between the two scenarios are not significant. The possible elimination of the RCZ in PFCAE-96 due to the large FEBA movement is not addressed. However, from a transportation viewpoint, the decrease in territory is likely to be offset by the frequent changes of routing and locations of postal facilities. Consolidated results are shown in Table 3-10 based on origin LR.

Table 3-10. Truck Company Requirements for Retrograde Mail

LR	TOE	PFCAE-96	PFASS
1	55719L200	.09	.07
2	55719L200	.09	.07
	55728L100	.02	.02
3	55718L200	.03	.02
	55727L100	.02	.02
4	55718L200	.08	.07
	55727L100	.01	.01
Totals	55718L200	.11	.09
	55719L100	.18	.14
	55727L100	.03	.03
	55728L100	.02	.02

3-9. UNIT MOVES (EXCEPT TRACKED VEHICLES). The average workload values for TP3-11 are shown in Table 3-11.

Table 3-11. Unit Move Workload for TP3-11 (STON) (PFASS\PFCAE-96)

	LR1	LR2	LR3	LR4
Average workload	113,800	178,200	66,000	18,200
	89,800	56,500	0	0

a. Resources/Capability

(1) Because unit vehicles are not available (all unit vehicles are, by definition, dedicated to a one-time move of TOE mobile weight), all NMWT and "other than NMWT" will be moved by corps and theater support medium trucks.

(2) The division must continue to actively defend throughout both scenarios. DISCOM trucks and the light-medium truck company will be largely supporting that effort. Division transportation assets are not going to make a sizable impact in helping LR1 units move the average daily PFCAE-96 workload of 11,380 STON. The corps medium lift trucks will be required to move the LR1 tonnage as well as the corps daily workload of 17,820 STON. The PFASS tonnage is less, but the same principle applies.

(3) Theater medium lift trucks will move the daily PFCAE-96 workload of 8,420 STON for LR3 and 4 (66,000 + 18,200 = 84,200/10).

(4) Trailers may be the limiting factor for unit moves, since the work involved is likely to be trailer-intensive; that is, trailers will be on location a relatively long time and may have to be positioned and repositioned.

(5) Materials handling equipment (MHE) will be in short supply.

Observation: the concept of unit mobility is relative. A combat unit in LR1 may in fact be 100 percent mobile if the TOE vehicles are able to move the unit TOE requirement in a single lift. However, the utility of the term "mobility" as used in TOE development breaks down dramatically when applied to support units. Conversations with the DISCOM commander and staff of the 1st Armored Division (AD) concerning their experiences in the Persian Gulf War reinforce this perception. Many TOE vehicles are not available to participate in a unit move because they are loaded with repair parts, fuel bladders, shop tools bolted to the vehicles, or committed to the staff. An inordinate amount of work would be needed to use the vehicles efficiently to move the units. The DISCOM battalions for the 1st and 3d ADs needed up to half a medium truck company in support of unit vehicles to perform the basic supply mission and keep up with the supported units. Even so, displacing some of the more sedentary units such as the aviation intermediate maintenance (AVIM) company was not done during the battle.

b. Analysis

(1) Unit movement is different from the preceding topics because the mission tonnage must maintain its position in the logical region from origin to destination. A corps unit that moves to the rear is still a corps unit once repositioned and will still be in LR2; a division unit will always stay in LR1. (Possible exceptions such as reconstitution are not currently included in transportation force structure calculations or implemented in FASTALS.) This single-LR characteristic leads to several hypotheses concerning the other characteristics of this type of retrograde workload.

(a) The preponderance of the workload remains in LR1 and 2.

(b) A tendency for direct origin to destination medium truck operation is more likely than using trailer transfer points.

(c) The ratio of time required in loading and unloading operations versus highway travel is likely to be higher than for inter-logical region movements.

(d) The weight per trailer load will likely be lighter than the standard transportation planning factor. There will be little packaging of materiel. The loading of tentage, uncrated equipment, and supplies by hand will reduce multiple layering of cargo. It can also be argued that the average weight of the unit mobile weight on unit vehicles will be less than standard planning factors, thereby creating an unexpected overflow for movement by nonunit trucks. For study purposes and to maintain a conservative approach, only standard planning factors for trailer loading will be used.

(2) A guide to whether unit moves are local or line haul can be gained from the unit move code (UMC) (see Appendix G). This indicator will provide an estimate on the low side for PFCAE-96 because it is not adjusted for the largest adverse FEBA movement.

(a) The vast majority of LR1 units relocate periodically in a time span of less than 3 days. That would indicate that LR1 unit moves would be local hauls. Result: PFCAE-96 requires 4.21 medium truck companies, TOE 55728L100; PFASS requires 3.33 truck companies (PFCAE-96: 11,380 STON/2,700 tons/day/truck co = 4.21).

(b) The UMC distribution of units from the corps to the COMMZ is not homogeneous. Table 3-12 provides a breakout of units by UMC for both scenarios. Generally, there should be an inverse correlation between frequency of move and NMWT, that is, the units that are increasingly sedentary have higher NMWT. There should also be a direct correlation between the UMC and the requirement for line haul because units that move infrequently should move a longer distance when a move becomes necessary. Of the 162 PFCAE-96 units in LR2, 51 have a UMC of either D or E. Therefore, for study purposes, it is reasonable to estimate 30 percent of the moves to be line haul. Result: PFCAE-96 requires 8.78 medium truck companies, TOE 55728L100; PFASS requires 2.72 truck companies (PFCAE-96: 17,820 STON X .70/2,700 STON/day/truck co = 4.62 truck cos local haul; 17,820 X .30/1,350 truck cos line haul; 4.62 + 3.96 = 8.58).

Table 3-12. Distribution of UMC for LR2

UMC	PFCAE-96	PFASS
A = (once in 3 days or less)	37	39
B = (once every 4-7 days)	24	45
C = (once every 8-17 days)	50	66
D = (once every 18 to 39 days)	36	41
E = (less than once every 40 days or more)	15	15
Total	162	206

(c) The UMCs for the RCZ and COMMZ have a lower percentage of units that move frequently than the corps, and the percentage of line haul missions can reasonably be expected to increase to 50 percent. Result: PFCAE-96 requires 3.19 medium truck companies, TOE 55727L100; the PFASS scenario requires no transport in LR3 and 4 (PFCAE-96: 8,420 STON X .5/3,960 = 1.06; 8,420 X .5/1,980 = 2.13 + 1.06 = 3.19).

c. **Conclusion.** The two scenarios produce significantly different requirements. Consolidated results are shown in Table 3-13 and are based on the average tonnage for TP3-11. Unit move average tonnage increases for each subsequent TP so that the greatest need for trucks occurs at TP11.

Table 3-13. Truck Company Requirements for Unit Moves

LR	TOE	PFCAE-96		PFASS	
1	55728L100		4.21		3.33
2	55728L100		8.78		2.72
3-5	55727L100	3.19		0	
Total		3.19	12.99	0	6.05

d. **Observation.** The study did not find any previous analysis, study, or simulation of unit move requirements. This is a failing that needs review not only because it could amount to a large workload, but also because the data needed to provide a good estimate of the workload has never been captured. It seems appropriate that TRADOC study what happens during a unit move, the effect of the unit move code, what items beside NMWT are to be moved, and the potential impact on the transportation system.

3-10. SUPPLY AND AMMUNITION STOCKS

a. Workload

(1) Table 3-14 provides an estimate of the tons of corps supply and ammunition onhand at any one time that may require evacuation during TP 3-11. The values were determined by removing the highest FASTALS value from the Supply and Consumption Table (usually for TP3) and dividing by the eight time periods remaining. As a result, the figures are slightly lower than shown in paragraph 2-10. Figures for both 2 and 4 days of advance warning time prior to movement are provided for comparison.

Table 3-14. Corps Supply and Ammunition Stocks (STON)

Supply class	PFCAE-96		PFASS	
	2 Days	4 Days	2 Days	4 Days
I	5,588	3,184	10,484	8,109
II	6,241	4,915	16,432	15,175
IIIP	1,010	789	3,886	3,647
IV	6,710	3,640	12,635	9,338
V	79,427	47,586	132,791	115,715
VI	93	*-629*	248	*-465*
IXALOC	2,322	2,021	2,108	1,810
IXNALOC	3,051	2,315	8,600	7,853
TOTAL	104,442	64,450	187,184	161,647

*Negative values are not considered in total.

(2) Class VII, of which a large proportion are vehicles, and Class VIII, medical supplies, of which some portion will be with hospitals, are not included. Class IIIB (bulk POL) will travel by tank truck, rail tank car, or pipeline.

b. Analysis

(1) Similar to unit moves, corps stocks moving to the rear are expected to stay in the same LR, and many of the same considerations raised during the discussion on unit moves apply to movement of stocks.

(2) PFCAE-96 ammunition stocks comprise 71 percent of the total tonnage in Table 3-14; for PFASS, it is 76 percent. However, the impact on retrograde truck operations that segregating ammunition-dedicated vehicles would have is not nearly as strong as the percentage of ammunition stocks would suggest.

(a) A disaggregation of FASTALS Workload 18, Dry Cargo and Unit Equipment by Truck, for TP2-11 indicates that on average the percentage of unit equipment is only 0.45 percent of the total for PFCAE-96 and 1.38 percent for PFASS. The unit equipment component is composed of only those moves from the ports to the staging area. The remaining 99.55 percent for PFCAE-96 and 98.62 percent for PFASS represented resupply tonnage and were disaggregated by supply class. The results are shown in Table 3-15.

Table 3-15. Workload 18 Average Supply and Ammunition Stocks (percent)

Supply class	PFCAE-96	PFASS
I	14.1	14.6
II	13.1	12.8
IIIP	3.2	3.9
IV	12.2	12.2
V	18.4	14.9
VI	12.6	12.6
VII	14.4	15.4
VIII	4.2	3.1
IXALOC	2.6	5.0
IXNALOC	5.2	5.5
Total	100.0	100.0
Total ton-hours	1,089,751	935,473

(b) Several comments concerning the percentages are appropriate to the retrograde of ammunition. The figures are nearly identical for both scenarios. The unexpectedly low percentage for Class V indicates that the DISCOM light-medium truck companies and HN rail, not medium truck companies, are prime movers of ammunition. The ton-hours for PFASS are 86 percent of that for PFCAE-96, a figure proportionally equal to a comparison of FASTALS total medium company force structure (PFCAE-96 = 73; PFASS = 64). The only significant difference, Class IX air line of communication (ALOC), may reflect the stability of the PFASS APODs in LR3-5 that is absent in PFCAE-96.

(c) The unexpectedly low Class V percentages called for a check to ensure FASTALS Workload 18 appeared reflective of the CEM battle. The check chosen reflected the intensity of the CEM battle to the degree of HET use for maintenance evacuation. Figure 3-4 shows that Workload 18 distribution of Class V by TP closely parallels the profile of HET lifts for maintenance evacuation. Since the profiles for Workload 18 and HET use are similar for each scenario, this check indicates that Workload 18 is performing as designed.

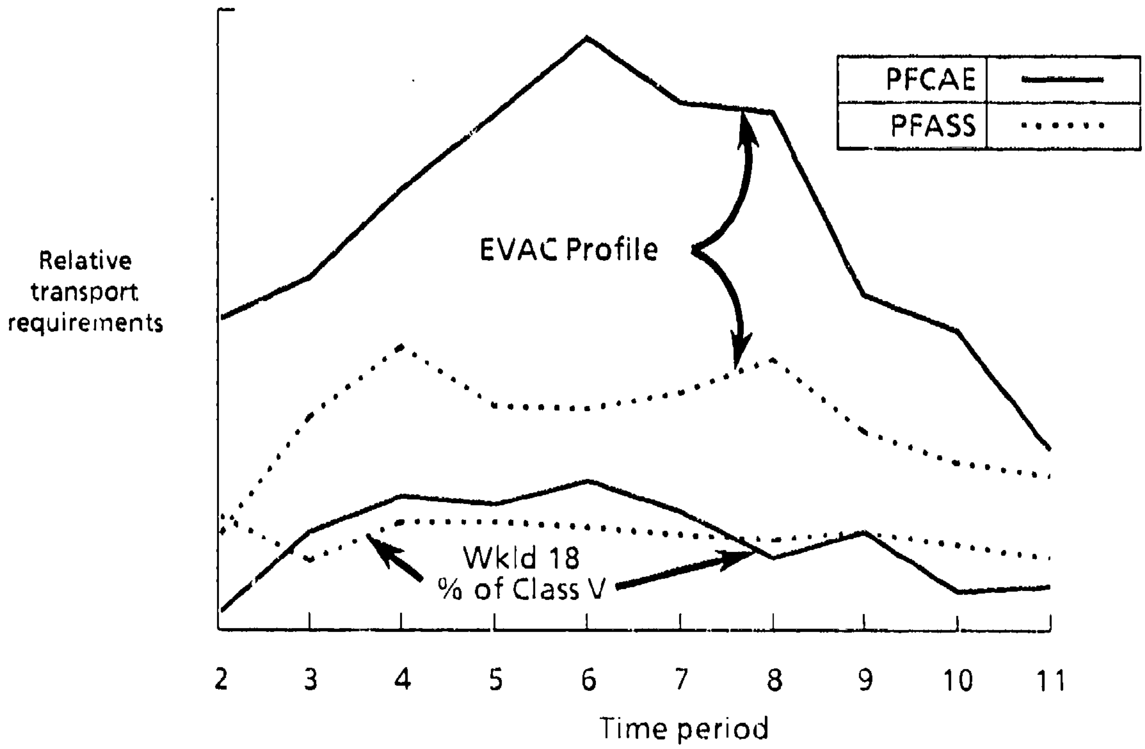

Figure 3-4. Ammunition Percentage of Workload 18 vs HET Maintenance Evacuation Profile

(d) Referring to Chapter 2, Table 2-18 for PFCAE-96, the average tonnage of ammunition to be retrograded per day for LR2 is calculated to be 2,977 STON (average Class V for TP3-11 = 89,322 STON X 3 stock moves/90 days). The Workload 18 breakout shows 200,136 STON.

(3) The number of movements for TP3-11 depends on the scenario and the interpretation of the need to move the stocks. Several alternatives to estimate the tonnage are possible.

(a) The UMC for units associated with the issue and storage of supplies and ammunition indicates that the supplies would move on the average of every 29 days. Using that criteria, total PFCAE-96 tonnage for the 2- and 4-day warning time is 313,326 STON and 193,350 STON, respectively. PFASS corps stocks are not threatened after TP8, when the FEBA starts to slowly move forward. Since the majority of the corps area is kept intact, for study purposes, only half of the stocks will move in retrograde and for only one time. Total PFASS tonnage becomes 93,592 (187,184/2) for the 2-day warning time and 80,824 STON for the 4-day warning time. Of note is the much higher percentage of supplies in the corps for PFASS which could impose a much greater imposition on transportation if the FEBA moved substantially to the rear.

(b) A second alternative focuses on FEBA movement versus the depth of the corps. For example, if LR2 depth was 70 km, supplies would have to move once per TP (PFCAE-96 average daily FEBA loss of 7.2 km X 10 days). The result would triple the 313,326 STON or 193,350 STON cited above. Any corps depth less than approximately 200 km will cause a higher number of moves of the tonnage compared to the alternative in paragraph 3-10b(3)(a) above.

(c) A third possibility is based on matching scenario FEBA changes to theater physical geography. The PFCAE-96 FEBA moves through several computer programmed physical regions during TP3. The displacement of the FEBA is not uniform, and the locations of depots must be matched to actual progress of the battle. Requirements would then be based on the distance estimates that the stores are moved.

(4) The question of whether supply and ammunition stocks would be moved using local haul or line haul depends on conditions such as depth of the corps and the degree of corps displacement. For example, the corps depth could be relatively large, but at 12 MPH (19.2 km), the AFPDA corps speed, an intracorps move of approximately 60 km would be the limit for local hauls not counting time for loading/unloading.

(5) In the RCZ and COMMZ, a requirement for the retrograde movement of stocks stored in depots could build on the structure of the existing plans for depot outloading primarily using rail by altering the destination railhead. Handling the cargo at the retrograde destination site would be impossible without a thorough peacetime plan for the site, materials handling equipment, and transport assets. The requirement for vehicles depends on the destination facility. A well-established supply depot should have rail facilities and little need for externally supplied truck transport between the storage bunker and the rail cars. Because destination facilities are an unknown, assume 50 percent of the supplies at the destination depot will require a local haul from the railhead to the storage site.

c. Alternative Argument. Given that the supplies in LR1 and 2 were captured by the enemy, the truck units generated by the FASTALS program to resupply LR1 and 2 units at their new location would offset truck units needed to retrograde the supplies being evacuated. Several responses are possible.

(1) The argument is basically one of supplies programming. If supplies would be in peacetime estimated danger of capture, the supplies that were captured should not have been located in the LR by the programmer. This is particularly true for the PFCAE-96 scenario, when withdrawal was continual and should have been foreseen. At most, this possibility should have happened only once.

(2) The continuing loss of tons of supplies in exchange for saving transport resources is not a policy of the US Army. Once lost, supplies cannot be replaced but may be needed in the future.

(3) Analysis of the FASTALS Supply and Consumption Table indicated that no supplies would be lost in LR1 for either scenario. This is the expected result as the program appears not to overstock LR1 units. If LR1 loses no stocks, it appears incongruous that stocks would be lost in LR2. The large FEBA loss in PFCAE-96 argues for concerted effort to mangage stocks such that LR1 units could "fall back" on the stocks positioned in LR2. Other stocks would either not be transported forward or would be retrograded to prevent capture. (This concept is included in 2- and 4-day warning analysis presented above.) PFASS is the more critical scenario because an enemy penetration catches the US with a greater volume of supplies stored forward in LR2 and a reduced transport capability to move the supplies to the rear.

d. Conclusion. Accepting one of several possible alternatives is necessary prior to estimating the impact on the transportation system. The conditions chosen represent a combination of several elements mentioned above.

(1) The PFCAE-96 estimate is based on the UMCs of supply units and a 2-day warning time. As an ameliorating factor, the tonnage will be evenly distributed over TP5-11, a 70-day period. This is reasonable because day D+28 (the first day a supply unit is expected to move) falls in the 9th day of TP5. The trucks are using line hauls, since each of the three moves has to travel approximately 200 km one way to cover the approximately 600 km of FEBA loss. Result: 3.32 medium truck companies, TOE 55728L100, are required to move supplies and ammunition (313,326 STON/1,350 STON/truck company/day = 232.1 truck company days/70 days = 3.32).

(2) The basis for the estimate for PFASS is that only half of the 4-day warning tonnage will move and will move only once. Additionally, local hauls are employed, and the tonnage is spread over TP5-8, a total of 40 days. Result: .75 truck companies (80,824 STON/2,700 STON/day/truck company = 29.9 truck company days/40 days = .75).

(3) A PFCAE-96 requirement (Table 2-18) to transport 50 percent of the LR3 and 4 destination railhead cargo to the new depot site was also identified in Chapter 2. The FASTALS TP4 value of 290,400 STON was the most

logical source of supply tonnage based of FEBA movement. For study purposes, the tonnage is distributed evenly over 20 days. Result: 3.67 medium truck companies, TOE 55727L100, are needed at the destination depot site (290,400/3,960 STON/day/truck company = 73.33/20 = 3.67)

3-11. CLASS VII AND IX PARTS. AMSAA provided retrograde parts weight data on a "maintenance event" basis, i.e., the FASTALS Logistics Report indicated that a tracked vehicle had either combat or noncombat (RAM) damage. Aircraft and wheeled vehicle repair parts were estimated by comparing the densities of those items with the tracked vehicles in each scenario and applying historical data. Table 3-16 shows the average workload for the retrograde of repair parts as developed in Chapter 2, Table 2-21, for TP3-11.

Table 3-16. Average Workload for Retrograde of Repair Parts (STON/day) (PFASS\PFCAE-96)

	CP and org to DS (LR1)	DS to GS (LR1 to LR3/4)	DS to Depot (LR1 to LR3/4)	GS to Depot (LR3/4 to LR4)
Average workload	244.32 308.47	130.08 86.89	137.94 230.69	87.86 36.18

a. Analysis

(1) Large drive train components are normally shipped in containers. Smaller items may be consolidated in large boxes suitable for handling by MHE.

(a) In LR1, the division light-medium truck company would normally provide the truck for delivering cargo from the CP and organizational activities to the DS/AVIM supply or recovery exchange section.

(b) In LR2-4, the corps and theater medium truck companies would provide transport. The expected procedure would be to deliver a loaded trailer at the DS/AVIM or GS maintenance activity and pick up a trailer that had been loaded with repairables destined for a higher maintenance level. The trailers may stop at one or more TTPs prior to delivery at either origin or destination maintenance activity.

(c) Maintenance for aircraft and vehicles is furnished by specialized units in all LRs which may not be in close proximity. This fact makes aggregating the weight mask the actually fragmented transportation needs.

(2) The total tonnage of 600 STON for PFCAE-96 and 662 STON for PFASS represents one of the few times that the PFASS retrograde requirement is higher.

(a) Depending on the TP, there are between 12 and 20 light-medium truck companies in the PFCAE-96 trooplist. The average daily repair parts evacuation in LR1 to DS is approximately 14 STON per division 244.32/16 truck cos = 14.02 STON). The PFASS average is 30.8 STON/day (308.47/CO truck cos = 30.847). It may not be reasonable to believe that standard cargo load factors apply for parts loaded at either the CP or the unit where speed and efficiency in repairing vehicles are more critical than full loading of supply vehicles for transport turnaround. Using a cargo load factor half of the normal, two local hauls by a tractor-trailer for a PFCAE-96 division and four for a PFASS division can provide sufficient lift. However, the light-medium truck company has 50 5-ton trucks versus only 10 tractors. The more likely approach would be to use 6 local hauls using light trucks for PFCAE-96 and 13 for PFASS (PFASS: 30.847/5 STON per truck/2 cargo reduction factor = 12.35 or 13 sorties). Result: .03 light-medium truck cos for PFCAE-96 and .07 for PFASS (13 local haul sorties/180 local haul sorties/day/co = .072).

(b) The tonnage from DS/AVIM to GS is less than that generated within LR1, but the travel distance dictates a line haul. Even so, it is difficult to envision transport by rail. The need for trucks to get to the origin railhead (and probably the destination railhead) and extra handling argue against use of rail. Corps medium trucks would periodically swap trailers at the DS/AVIM units. On average, nine sorties per day for PFCAE-96 and six sorties for PFASS are needed (PFCAE-96: 130.08 STON/15 STON per sortie = 8.67 or 9 sorties). Result: .10 medium truck cos (corps) for PFCAE-96 and .07 cos for PFASS.

(c) For transportation calculation purposes, the travel time between DS to GS and DS to depot are equivalent--both are line haul. PFCAE-96 requires 10 sorties per day from GS to depot, and PFASS needs 16 (PFASS: 230.69 STON/day/15 STON/sortie = 15.37 sorties/day). Result: .09 medium truck cos (corps) for PFCAE-96 and .18 for PFASS.

(d) The distance between the GS and depot facilities is more likely to require a line haul than a local haul. Use of rail is possible, and even likely, given the assumptions used earlier that all depots and 50 percent of GS facilities would have rail access. Therefore, the limits of the possibilities become 100 percent line haul to a minimum of 50 percent local haul to get to the GS railhead. For study purposes, repair parts transport will be considered as 100 percent local haul. The tonnage is relatively small. PFCAE-96 requires four sorties and PFASS needs two sorties (PFCAE-96: 87.86 STON/day/22 STON/sortie = 3.99 or 4 sorties). Result: .02 medium truck cos (theater) for PFCAE-96 and .01 for PFASS.

b. **Conclusion.** The retrograde of repair parts requires a relatively small amount of transport assets. Consolidated results are provided in Table 3-17.

Table 3-17. Truck Company Requirements for Repair Parts

Mission	TOE	PFCAE-96			PFASS		
CP & org/AVIM to DS (LR1)	55719L200	.03			.07		
DS/AVIM to GS (LR1 to LR3/4)	55728L100			.10			.07
DS/AVIM to depot (LR1 to LR3/4)	55728L100			.09			.18
GS to depot (LR3/4 to LR4)	55727L100		.02			.01	
Total		.03	.02	.19	.07	.01	.25

3-12. MAINTENANCE EVACUATION (TRACKED VEHICLES). The number of lifts required was a result of the HET analysis described in paragraph 2-12 and Appendix F. The average workload was 2,836.45 lifts in LR1 and 206.11 lifts in LR2-4 for PFCAE-96. PFASS required 1,546.67 lifts in LR1 and 64.89 lifts in LR2-4.

a. Analysis

(1) The percentage of line versus local haul is central to determining the number of HET companies needed to move a specific number of vehicles. Figure 3-5 provides a visualization of the workload division provided by the Transportation School. The schematic stops at GS because there were no AMSAA maintenance profiles that used depot maintenance.

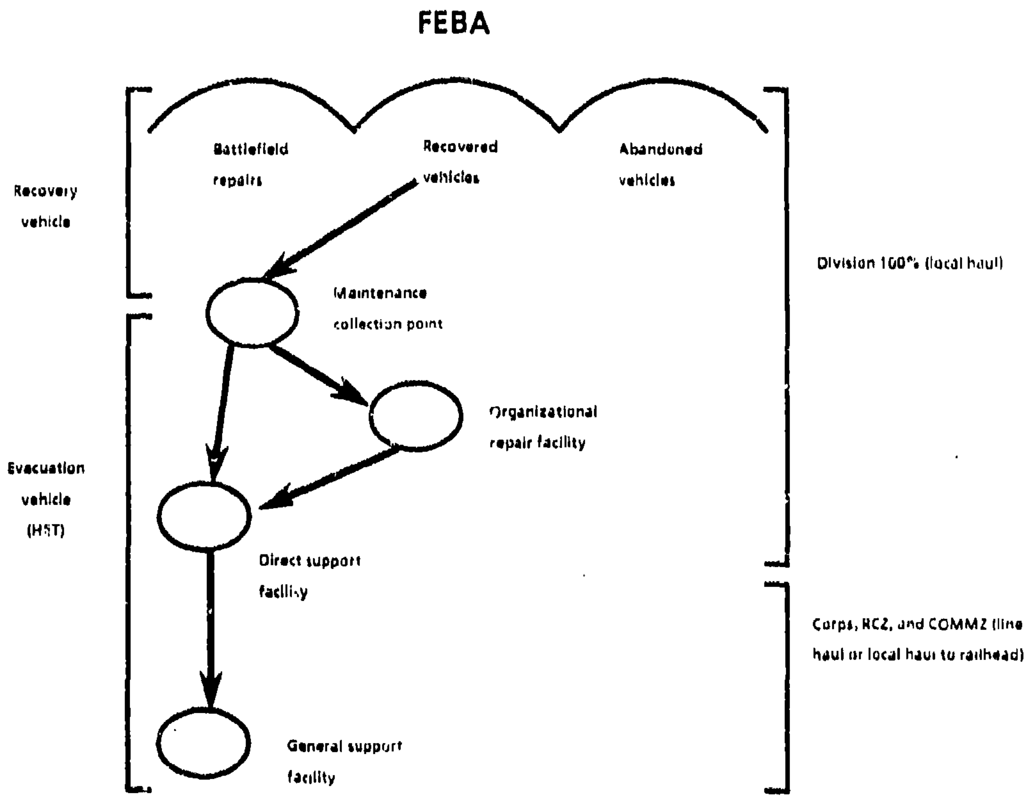

Figure 3-5. Schematic of Recovery vs Evacuation and HET Local vs Line Haul

(2) The spreadsheet analysis determined the HET lifts required for maintenance backhaul and for vehicles salvaged to the rear of the CP. Subsequent to that process, the number of lifts was distributed through the transportation structure to accrue the specific transportation link workload for the HETs.

(3) For each 4-day time period in CEM, the number of temporary and permanent losses from combat or noncombat events was entered into the spreadsheet. One function of the spreadsheet is to calculate the number of HET companies needed to perform the maintenance evacuation mission. Table 3-18 provides the minimum number of HET companies needed for each scenario. The data is charted in Chapter 5, Figure 5-2, as part of a more comprehensive discussion of HET requirements. Using an average HET company requirement statistic is in keeping with the format throughout Chapters 2 and 3 but is considered only as an interim result at this stage of analysis.

Table 3-18. Heavy Truck Requirements for Maintenance Evacuation

4-day Period	PFCAE-96	PFASS
1-4	3.84	.34
	2.64	2.02
	4.49	2.24
	4.57	2.78
17-20	5.92	3.37
	5.98	2.47
	7.10	2.38
	8.76	2.45
	8.37	2.37
37-40	7.32	2.43
	7.33	2.59
	6.91	2.54
	7.13	3.16
	6.49	2.99
57-60	5.38	3.19
	4.61	2.89
	3.83	2.70
	3.26	2.59
	2.91	2.50
77-80	2.44	2.38
	2.11	2.49
	1.93	2.43
	1.80	2.36
Average	5.01	2.51

b. Conclusion. The average number of HET companies needed for the base case analysis was 5.01 for PFCAE-96 and 2.51 for PFASS.

c. Observation. Maintenance evacuation is the a secondary mission for the HET. No value was added for the primary misson of ferrying operable vehicles toward the FEBA.

3-13. UNIT MOVES (TRACKED VEHICLES). This topic interlocks with both the maintenance evacuation (paragraph 2-12 and Chapter 5) and unit moves discussed in paragraphs 2-12 and 3-9. Table 3-19 provides the average daily workload for tracked vehicle movement needed to support unit moves.

Table 3-19. HET lifts to Support Unit Moves (PFASS\PFCAE-96)

	Organization	Direct support	General support
Average	66.39	24.40	1.06
workload	45.92	14.04	.81

b. Analysis

(1) A maintenance unit required to relocate must move not only the unit's equipment, but also the items in the shops being fixed and the items onhand waiting to be fixed. There also may be items that are repaired waiting for customer acceptance. Inoperable tracked vehicles will require a HET. Wheeled vehicles and other equipment on site must also be moved, but ETRANS includes the weight of those items in the "other than NMWT" factor introduced in paragraph 2-9.

(2) As with all unit moves, the tracked vehicles being moved will stay in the same LR. A large majority of the repair work of whole vehicles is done in LR1 at the organizational and DS levels. (The vehicles at the CP are included in paragraph 2-12; otherwise, they are salvaged.)

(3) There will be no reasonable availability for a backhaul in LR1 because repaired vehicles move forward under their own power in LR1. In the rear, the few times a GS unit will move and the relatively few whole vehicles at a GS site allow for only a small potential backhaul capability.

(4) In keeping with the format used in the HET analysis in Chapter 5, HETs supporting combat unit moves will be considered as 100 percent local haul. HETs supporting DS units will be 60 percent local/40 percent line haul, and moves for GS facilities will be 100 percent line haul. PFCAE-96 DS calculation: 24.40 X .6 local haul = 14.64/18 available trucks/co = .81/4 hauls/day = .20; 24.40 X .4 line haul = 9.76/18 = .54/2 hauls/day = .27; .20 + .27 = .47.

c. Conclusion. The PFCAE-96 values in Table 3-20 are particularly conservative because of the low values for later TPs in Table 2-30.

Table 3-20. HET Companies to Support Unit Moves (PFASS\PFCAE-96)

	Organization	Direct support	General support	Total
HET	.92	.47	.03	1.42
COS	.63	.27	.02	.93

3-14. TACTICAL RELOCATION (TRACKED VEHICLES). Recent (mid-CY 1991) doctrinal discussions concerning the use of HETs for operational uses indicate that such use may be standard procedure in future years.

a. Analysis

(1) A task force is composed of several types of tracked vehicles to include tanks, APCs, retrievers, mortar carriers, artillery, and command vehicles. Not all vehicles have sufficient gross weight to specifically require a HET. Some APCs, mortar carriers, and command vehicles fit in this category.

(2) The terms "low bed" and M871/872 are used to designate vehicles designed to carry tracked vehicles but not having the capacity of HETs. Generally, these vehicles are assigned to engineer and maintenance units based on the requirement to transport engineer vehicles to work sites or recover inoperable vehicles to maintenance facilities.

(3) During war, the primary mission will keep assigned vehicles occupied. Chapter 5 indicates that additional vehicles will be needed to aid in the evacuation of combat-damaged vehicles. If engineer vehicles accompany the task force, non-HETs could be part of the lift force.

(4) HETs which are not part of heavy truck companies are not separately identifiable in FASTALS force structure entries. As the task force relocation mission is a theaterwide requirement, it is reasonable to believe that the mission should be performed by vehicles that are not embedded in a low-level TOE.

(5) A recent TRADOC working group proposal was for a 96-truck HET company to be formed specifically for this mission. At 75 percent availability, 72 trucks could reasonably transport a task force using two line hauls per HET. Some vehicles, M113s and 577s, for example, would have to be doubled up on each HET.

b. Conclusion

(1) It may be questionable whether this subject is appropriately included as a retrograde movement. The expectation is that usually the movement would be lateral to the FEBA. The possibility of a backhaul for the relocation mission is low unless there is an inoperable truck at the destination area that must be returned to the origin for repair.

(2) For study purposes, a theaterwide HET force of four 24-truck companies is a reasonable solution for this emerging requirement.

3-15. CAPTURED ENEMY MATERIEL, DENIAL OPERATIONS, AND STRATEGIC MATERIALS. These missions were covered in Chapter 2, paragraph 2-15. No further consideration is warranted.

3-16. RECAPITULATION OF TRUCK REQUIREMENTS. The average truck requirement for retrograde PAX and cargo is totaled in Table 3-21 based on the results of the previous paragraphs in this chapter. The figures do not consider that some of the retrograde requirements may by reduced due to the effects of backhauls (see Chapter 4).

Table 3-21. Truck Companies Based on Retrograde Requirements (PFASS\PFCAE-96)

Mission	LR1 Light	LR1 Medium	LR2 Light	LR2 Medium	LR3-5 Light	LR3-5 Medium
EPW	.03 .03		.03 .03		.03 .03	
Medical	N/A N/A		N/A N/A		N/A N/A	
NEO	N/A N/A		N/A N/A		4.62 3.70	
KIA	.29 .15			.35 .17		
Mail	.09 .07		.09 .07	.02 .02	.11 .09	.03 .03
Unit moves		4.21 3.33		8.78 2.72		3.19 0
Supply & ammo stocks		0 0		3.32 .75		3.67 0
Class VII & IX parts	.03 .07			.19 .25		.02 .01
Captured mat, denial opns, & strategic mat		n/a		n/a		n/a
Total	.41 .25	4.21 3.33	.12 .10	12.47 3.66	4.76 3.82	6.89 .03

Heavy Trucks

Mission	LR1	LR2	LR3-5
Maintenance evacuation	5.00 2.51		
Unit moves (trac veh)	1.39 .91		.03 .02
Tactical relocation		4.00 4.00	
	6.39 3.42	4.00 4.00	.03 .02

CHAPTER 4

RETROGRADE INTEGRATION

4-1. PURPOSE. To develop a method of combining the gross retrograde light and medium truck requirements developed in Chapter 3 with forward-moving transportation assets and estimating the net total force structure required for retrograde missions.

4-2. INTRODUCTION

a. Recent thought concerning retrograde transportation could be contained in three sentences. First, backhaul requirements were assumed to be negligible compared to forward movement requirements. Second, the performance of a backhaul mission was assumed not to degrade the forward movement mission. Lastly, adequate backhaul transportation resources were assumed to be available as a result of the first two notions. Those answers appear too simplistic in light of the discussion of several of the topics in Chapter 2.

b. The method developed to combine the forward and retrograde missions is unique to this study and should not be interpreted as a preferred method or the ultimate solution.

c. The use of average workload requirements in Chapter 2 led to sizing the number of truck companies to perform the average retrograde mission in Chapter 3. This may be satisfactory for PFASS, but it is of significant detriment to PFCAE-96 because of its widely varying TP workloads and the character of the curve that is portrayed by those workloads, i.e., the heavier requirements are in the earlier TPs.

4-3. BACKHAUL. A truck that completes a delivery or drops a trailer at a destination and subsequently picks up additional cargo or another trailer for delivery back to the initial or first origin (second destination), is performing a backhaul. There are several examples of backhauls.

a. A direct backhaul occurs when a truck carries passengers or cargo in both directions while going from origin to destination and back to the first origin. Time may be expended while unloading and loading at the destination (also the second origin) and checking documentation, but no time is expended traveling without having passengers, cargo, or a loaded trailer after the first origin.

b. A three-point backhaul occurs if the truck discharges passengers or cargo at the destination and must travel to a second location (origin) to pick up passengers or cargo for delivery to the first origin. In a variation of that example, the truck picks up cargo or passengers at the destination for delivery to a second destination prior to returning to the first origin. In both instances, one leg of the route is "dead time" (i.e., traveled without carrying passengers or cargo).

c. A four-point backhaul differs from the three-point backhaul in that there is dead time between the first destination and the second origin pickup as well as between the second destination and the first origin. Several other complicated possibilities exist such as a fixed route having several locations that may or may not have passengers/cargo available to move at that time. Figure 4-1 depicts the three types of backhauls described herein. The dotted segments represent dead time.

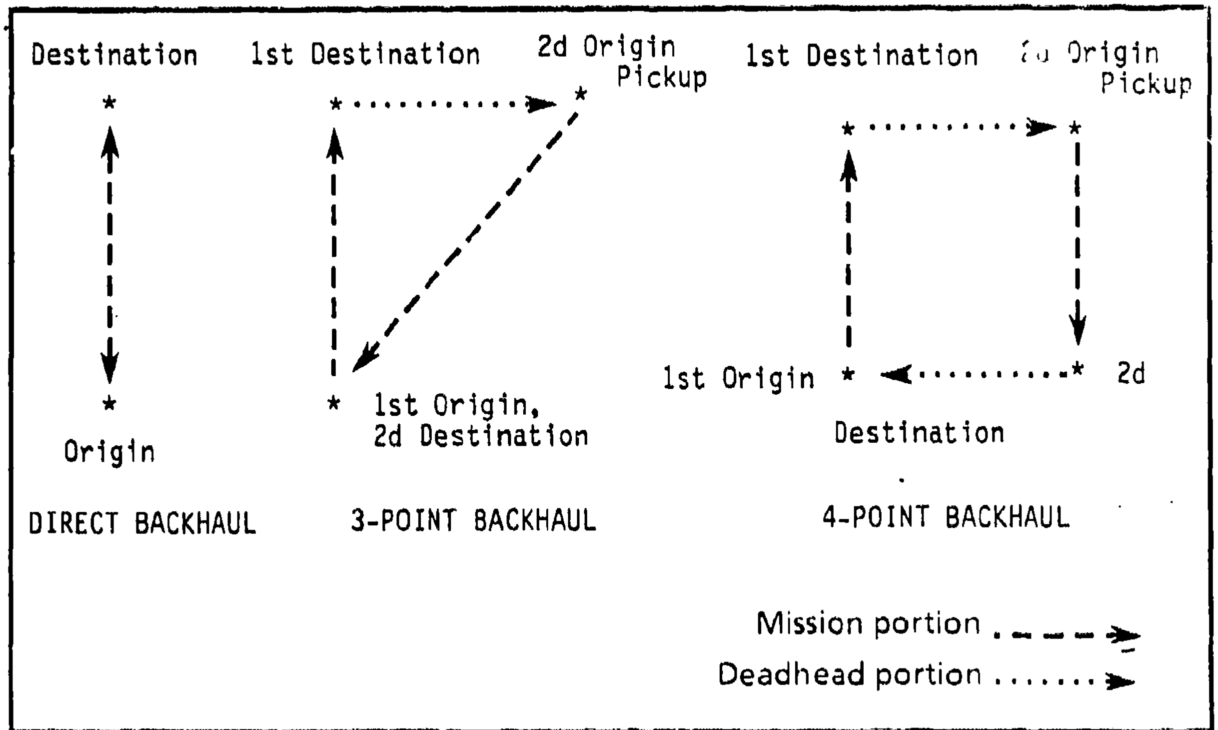

Figure 4-1. Three Examples of Backhauls

4-4. THE TRAILER TRANSFER POINT (TTP). TTPs are located at predetermined points along the main supply route (MSR) and are the "hubs" of a hub and spoke system. Local hauls, the "spokes," fan out from the TTP, while trucks on line haul transport trailers and containers between the TTPs. Medium truck operators use TTPs for trailer exchange, documentation, cargo inspections, and to provide mess, maintenance, and other support if available. Figure 4-2 depicts a hub and spoke operation, and the asterisk represents final destinations of cargo. A medium truck company will always attempt to locate its operating base at or near the TTP to reduce dead time "commuting" to the TTP.

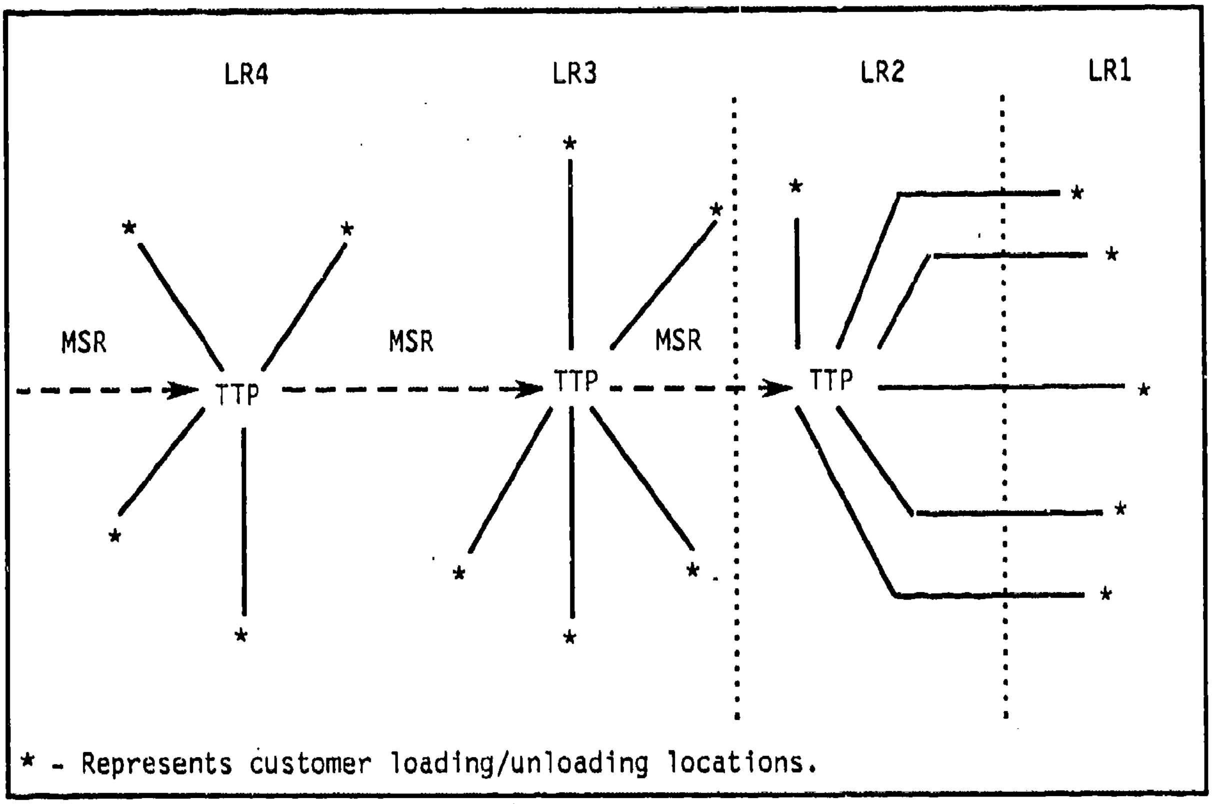

Figure 4-2. "Hub and Spoke" Transportation System

a. TTPs allow maximum use of tractors and trailers. The ratio of trailers to tractors changes from 2.5 to 1 for the medium truck company at the corps, TOE 55728L100, to 2 trailers per tractor for the theater medium truck company, TOE 55727L100. Depending on the flow of operations, the limiting factor could be either tractors or trailers. No existing queueing model that adequately mimics medium truck operations could be found.

b. A typical medium truck company will normally have 45 of its 60 tractors (75 percent availability) and 135 of its 150 trailers (90 percent availability) on the road each day. Most of the tractors are moving on the MSR. Those bringing loaded trailers forward will leave them at the TTP and immediately pick up empty trailers, or trailers loaded with retrograde cargo, for return trips to the next TTP rearward along the MSR of the COMMZ. A few of the tractors will be retained at the TTP to ferry trailers to customers within the local operating area. If possible, the tractor will pick up an empty trailer at the destination (direct backhaul) or from a nearby location on the return (three-point backhaul) to the TTP.

c. The local movement control activity must continuously determine how best to divide the tractor assets between ferrying trailers locally or moving them on the MSR. From the discussion of the various retrograde missions in Chapter 3, it is easy to visualize the difference between supplying trailers for loading by units that must relocate versus moving supplies and ammunition in a storage area. The first may need several empty trailers for the relatively long process of hand loading (e.g., tentage, basic load, tools/ equipment) while the second may be able to quickly load containers of Class V with a forklift.

d. US tractors cannot trade trailers with the host nation vehicles. The fifth wheel-kingpin assembly and electrical/hydraulic couplings are not compatible. No practical remedies for this problem are reasonably available. The result is that both the US and the host nation often have parallel operations over the same route structure.

4-5. MOVEMENT CONTROL

a. A single US organization performs movement control for the Central Region RCZ/COMMZ. It has directive authority, but not command, over the US corps movement control centers. The Central Region has a system of reporting points that may include a TTP that provides instructions to the trucks traversing the MSR. The host nation retains traffic regulation, the authority to allow road use, route clearances, and designation of priorities for movement. The US has the obligation to inform the host nation of its need to use the roads.

b. The corps commander is responsible for all movement control and traffic regulation within the corps area. The corps may operate one or more TTPs. The division commander has similar authority for the division area, but there are no TTPs in the division. Corps truck companies are often used to transport personnel and cargo between the corps and division areas. Division trucks generally are used for transport in the division area.

4-6. THE BACKHAUL INTEGRATION FACTOR

a. No method of combining forward and retrograde cargo movements exists other than that exercised by the movement control organizations on an *ad hoc* basis.

b. The characteristics of retrograde missions, types of backhauls, truck operations, and movement control were some of the subjects that combat development representatives from the Transportation School considered when informally proposing a backhaul integrating factor for truck companies. Based on combat experience, knowledge of European operations, and transportation doctrine, a range of .15 to .50 was determined to be a reasonable value for a backhaul integration factor. A value of .15 would mean that an overall transportation efficiency gain of 15 percent is realized when a retrograde mission is added to a truck's one-way-only mission. If the backhaul factor is .40, which provides a 40 percent efficiency, then the forward mission proceeds routinely, and the backhaul saves 40 percent of a second vehicle normally needed for the backhaul (only) mission.

c. The application of the backhaul factor is based on the discussion of the individual mission and estimated on the basis of military knowledge. There are no values developed by experience or doctrine that can be applied at this time.

d. The backhaul integration factor has a direct effect on force structure by averaging the effects of backhauls for all vehicles in the truck company. To illustrate, suppose that there were 10 tons of cargo for movement at each of two locations, the destination of the first cargo mission being near the origin site of the second cargo mission. Five-ton trucks will be used. Movement control has two alternatives: first, two light trucks could be dispatched to complete both 10-ton movements by including backhauls; second, four 5-ton trucks would be assigned to transport 5 tons each in one direction only. Given an integration factor of .4, the two trucks would take 1.6 times as long to transport all 20 tons rather than only 10 tons in one direction. In this example, the mission equates to 3.2 trucks needed when the backhaul is done versus the 4 trucks needed for the one-way missions (2 trucks forward + 2 retrograde = 4 - (2 X .40 = .8) = 3.2). The backhaul integration factor to be expected for specific missions would be developed by averaging the experience of many missions over time.

e. The FASTALS program does not currently accommodate a reduction of force structure for backhauls, but once retrograde missions are added, the application of the backhaul factor for retrograde missions to FASTALS could produce a requirement for more units. To extend the illustration above, if 10 light truck companies were justified by workloads moving forward, then adding a backhaul mission to every forward mission identified in FASTALS would require 6 light truck companies to be added to the force structure (10 forward + 10 rearward = 20 - 4 [.4 efficiency factor X 10] = 16.0). If backhauls were included for only half the forward missions for the 10 companies justified by FASTALS, then 3 additional light truck companies would be needed.

4-7. SEGREGATION OF CLASS V. The RETRO II study position was that retrograde of ammunition would be done using trucks dedicated for transporting ammunition forward without a force structure penalty. That position may reflect a battlefield priority for ammunition movement, but it has two deficiencies.

a. First, when depot locations are displaced rearward and retrograde of Class V is necessary, it is reasonable to believe that ammunition trucks would come forward from rear areas to the newly designated storage location rather than to the site being evacuated. Therefore, an additional mission leg is still necessary for them to travel to the old location to evacuate ammunition remaining there. The distance between the new location (first destination) and the old site (second origin) is dead time which adversely affects efficiency. Time is also consumed between the second origin and the second destination. In addition, the loading and unloading for the backhaul load further delays the truck from returning to the first origin.

b. Second, the percentage of trucks dedicated to move ammunition could be relatively large. The practice of automatically isolating trucks for ammunition movement restricts the flexibility of movement control to use available assets in the most efficient manner. This is particularly true if

the number of nonammunition backhauls exceeds the nonammunition trucks available. It also appears to preclude the use of trucks assigned other missions from being assigned to transport ammunition should an ammunition storage site need a hasty evacuation. However, from the discussion of Workload 18 in paragraph 3-10, the percentage of ammunition tonnage is lower than the Class V stock levels would initially indicate. Isolating ammunition trucks would not appear to adversely affect other transport needs. In fact, if ammunition trucks were isolated, it could be detrimental to Class V transport, as some drivers needed to move Class V in an emergency may not have been properly trained.

c. Other factors could play a role in the future as procedures for the transport and handling of ammunition are changed. Combat development personnel at the Transportation School expect the transport requirements for Class V to increase as the Maneuver Oriented Ammunition Distribution System (MOADS) is implemented. The potential for follow-on changes such as the MOADS-Palletized Loading System concept may pose additional constraints.

4-8. BACKHAUL FACTOR APPLICATION TO RETROGRADE MISSIONS. The force structure identified in Chapter 3 must be evaluated to determine the backhaul factor appropriate to calculate the additional force structure justified for retrograde missions. Many factors bear on the degree of backhaul efficiency attainable, among them are ease of loading/unloading, amount of dead time expected, type of truck used for primary mission, location of cargo pickup or dropoff, and expected availability of backhaul missions. Retrograde missions that were determined to require light or medium transport assets in Chapter 3 are addressed below. No discussion of medical, NEO, captured material, denial operations, and strategic materiels is necessary as none has been determined to warrant assignment of assets. Backhaul possibilities for maintenance evacuation, tactical relocation, and unit moves (tracked vehicles) are included in the HET analysis in Chapter 5.

a. Enemy Prisoners of War

(1) The requirement is .03 light truck companies each for LR1, 2, and 3-5 for both scenarios.

(2) Trucks for EPW transport are needed in LR1 and 2. Trucks can be expected to be replaced with HN rail and buses in LR3-5.

(a) In LR1, the EPW go from the division EPW collection point in the division rear to the corps EPW collection point. Virtually no time is spent loading or unloading mobile prisoners. Both the origin and destination should be near support activities which will limit the effect of the dead time and improve the opportunity for backhaul. Result: a backhaul factor of .50 appears reasonable.

(b) The EPW transport requirement in LR2 centers on bringing prisoners from the corps EPW collection point to the HN railhead in the corps rear. The same considerations apply to this mission as applied to LR1 and the same backhaul factor is appropriate, as there should be sufficient vehicles needed at the railhead to transport cargo forward. Result: a backhaul factor of .50.

(c) The LR3-5 requirement stems from the need to bring prisoners from the destination railhead to the internment camp. There should be little need to transport passengers that have a guard requirement in reverse. Result: a backhaul factor of .15.

(3) The effect of the backhaul factor adjusts the gross retrograde mission requirements to reflect the following actual requirements: LR1 and 2, .02 TOE 55719L200 and for LR3-5 .03 TOE 55718L200, for both scenarios (calculation: LR1&2, .03 X .50 = .015; .03 - .015 = .015 rounded to .02; LR3-5, .03 X .15 = .0045; .03 - .0045 = .0255 rounded to .03).

b. Medical Evacuation. No common user transport required.

c. Noncombatant Evacuation Order (NEO)

(1) No transport was needed in LR1 and 2.

(2) Paragraph 3-6 identified a very large requirement minimally estimated at 4.62 TOE 55718L200 for PFCAE-96 and 3.70 for PFASS just to get NEO evacuees to a rail station or APOE. A backhaul factor could be appropriate, at least in part, because of the need to transport the requirement generated by Workload 19 to get replacements to the replacement centers. However, to offset the high potential for substantial line haul requirements to transport NEO to and in LR4-5 or satisfy arrangements other than the minimal transport to the rail station or APOE, no backhaul factor is applied.

d. Killed in Action

(1) The average daily values for light-medium truck companies, TOE 55719L100, and medium truck companies, TOE 55728L100, for PFCAE-96 is .29 and .35, respectively. The average values for PFASS are .15 light-medium truck companies and .17 medium truck companies per day.

(2) Light trucks are used to transport KIA within LR1, and medium trucks are used from LR1 to LR4.

(a) The nonunit light trucks (ETRANS allocated unit trucks for 60 percent of the LR1 workload) travel between the brigade and the division KIA collection point usually located in the DISCOM area. A normal function of the light vehicles in LR1 is to transport cargo from the DISCOM supply points to the maneuver brigades; therefore, backhauls are reasonable. Result: backhaul factor is .50.

(b) Line haul by medium truck will be used to transport remains from the division to the theater mortuary which is anticipated to be near a theater APOE. A significant amount of cargo, including Class IX ALOC, for example, will be available to backhaul to the corps and division along the truck's return route. The degree of dead time for the three-point backhaul should be relatively small compared to the total distance of the line haul. Result: backhaul factor is .50.

(2) The results calculated in Chapter 3 are reduced to yield a requirement of .15 (PFCAE-96) and .08 (PFASS) light-medium truck companies and .18 (PFCAE-96) and .09 (PFASS) medium truck companies.

e. **Mail Transport**

(1) The retrograde requirements for mail are shown in Table 4-1.

Table 4-1. Truck Company Requirements for Retrograde Mail

TOE	PFCAE-96	PFASS
55718L200	.11	.09
55719L200	.18	.14
55727L100	.03	.03
55728L100	.02	.02

(2) The backhaul factor is difficult to apply to the transport of mail. The initial problem is that the movement of mail, either forward or retrograde, is not programmed in FASTALS. The mail goes between post offices in both directions and is unlikely be combined with other cargo. A second consideration is that it is probable that more mail is brought forward than carried in retrograde. Depending on the character of the war (degree of popular support, for example), incoming mail tonnage could be several times that of retrograde mail.

(3) The likelihood that a vehicle would be eligible for a backhaul mission other than forward-moving mail is low.

(4) Because FASTALS-generated truck requirements appear to be understated by the amount of mail moving forward in the theater, no backhaul factor is appropriate. The reverse is a more reasonable treatment for mail. Therefore, for study purposes, an appropriate conservative estimate is to regard the retrograde tonnage as a minimum forward-moving requirement and to add a backhaul factor of .50. For example, the PFCAE-96 value of .11 for TOE 55718L200 in Table 4-1 now becomes .17 (.11 X .5 = .055; .055 + .11 = .165 rounded to .17).

(5) The resulting total force structure needed for mail transport is shown in Table 4-2.

Table 4-2. Total Force Structure Required for Mail

TOE	PFCAE-96	PFASS
55718L200	.17	.14
55719L200	.27	.21
55727L100	.05	.05
55728L100	.03	.03

f. **Unit Moves (except tracked vehicles).** The number of truck companies needed to aid in unit moves is shown in Table 4-3.

Table 4-3. Truck Company Requirements for Unit Moves

LR	TOE	PFCAE-96	PFASS
1	55728L100	4.21	3.33
2	55728L100	8.78	2.72
3-5	55727L100	3.19	0

(1) A determination must be made whether normal transport activities are occurring at the time the units are being moved rearward in LR1.

(a) For PFCAE-96, it is evident that the withdrawing force in LR1 can fall back on supplies rather than require the large daily resupply effort normally needed to sustain an army. Scarce items and ammunition may be coming forward, but items not critical to immediate operations will be delivered to locations to the rear of current positions. Because transport requirements may be less, the number of medium trucks in LR1 may be less than normally expected; therefore, the number of trailers available for backhaul are relatively few. The backhaul penalty on tractor-trailer operations can be expected to be greater than if transport requirements were normal. Result: the backhaul factor is estimated to be .35.

(b) The situation in PFASS is much different. The slow pace of FEBA movement means that daily resupply will take place routinely. A large number of trucks, tractors, and trailers should be available. Result: the backhaul factor is estimated to be .50.

(2) Movement of units in LR2 is not as likely to find transport assets as scarce; however, distance and the location of the move can greatly affect the effectiveness of those assets available. The movement of units must be done so that the dislocation takes the minimum amount of time because a unit is not functional when packed up or moving on trailers. This consideration may adversely impact the manner of traffic and vehicle control normally exercised over the transportation system.

(a) Corps units moving rearward can be serviced by tractors hauling supplies forward to and through the corps and by trucks returning from LR1. A shortage of trailers may develop if many units are moving at once. Most backhauls will entail some dead time either going to the unit's original location or between the second destination and the next origin.

(b) The distance of the move will be the determinant of whether local or line hauls are necessary. Some line hauls can be expected, and in paragraph 3-9, a conservative estimate of 30 percent was anticipated for both scenarios. The continuous need for moving units and the large FEBA losses could easily translate into a much higher line haul percentage for PFCAE-96.

(3) The problems of distance and location in LR2 are magnified in LR3-5. The only advantage to be gained is that road speed should be higher.

(4) Unit moves generate the majority of medium truck requirements for retrograde movement. Any backhaul factor less than .50 will cause significant force structure increases. For example, a factor of .50 for the PFCAE-96 LR2 retrograde requirement (8.78 medium truck companies) would dictate a need for 4.39 additional companies instead of 8.78, but a factor of .15 would indicate a need for 7.46 companies.

(5) Result: a backhaul factor of .40 for LR2 and .30 for LR3-5 was deemed appropriate. The results are shown in Table 4-4 (calculation for LR1 PFCAE-96: 4.21 X .35 = 1.47; 4.21 - 1.47 = 2.74 medium truck companies).

Table 4-4. Truck Company Requirements for Retrograde Unit Moves

LR	TOE	PFCAE-96	PFASS
1	55728L100	2.74	1.67
2	55728L100	5.27	1.63
3-5	55727L100	2.23	0

g. Supply and Ammunition Stocks. This topic also generates significant medium truck requirements. FASTALS does not identify any "move or lose" stocks in LR1 based on the spreadsheet analysis used by the study. There are significant supplies and ammunition stocks to be moved for PFCAE-96 in LR2 (3.32 medium truck companies) and in LR3-5 (3.67 companies). PFASS generates .75 truck companies only in LR2.

(1) Loading supplies and ammunition for retrograde should be faster and more efficient than that experienced for unit moves because it is packaged and can moved by onsite MHE.

(2) Trailers are not expected to be a limiting factor.

(3) The degree of backhaul potential may be relatively high as the transport of shortage items forwara to support the corps and divisions should provide an adequate source of medium trucks. Dead time should be low.

(4) This mission appears to be most favorable to backhaul integration in LR2. Result: a backhaul factor of .50 is appropriate. The number of PFCAE-96 medium truck companies required for evacuation of supplies and ammunition becomes 1.66 for LR2 and 1.84 for LR3-5. PFASS needs .38 companies for LR2 only.

h. Class VII and IX Parts. The truck requirements for this topic are listed in Table 4-5. Table entries are totaled by truck company TOE.

Table 4-5. Truck Company Requirements for Repair Parts

Mission	TOE	PFCAE-96			PFASS		
CP & org/AVIM to DS (LR1)	55719L100	.03			.07		
DS/AVIM to GS (LR1 to LR3/4)	55728L100			.10			.07
DS/AVIM to depot (LR1 to LR3/4)	55728L100			.09			.18
GS to depot (LR3/4 to LR4)	55727L100		.02			.01	
		.03	.02	.19	.07	.01	.25

(1) The characteristics of repair parts evacuation are similar to those of supply and ammunition stocks. The shipment of parts is standard procedure, and the maintenance organizations are staffed and equipped for returning recoverable repair parts to higher maintenance facilities. Backhauls are common and expected. More parts are expected to be moving forward in the system than are moving to the rear. Trailer exchange should be a quick procedure.

(2) The trailers may not be loaded to a standard weight as full loads may not be attainable prior to the next load of parts arriving for trailer exchange. The overall effect may not be detrimental because of the expected efficiency of the backhaul.

(3) Result: a backhaul factor of .50. is appropriate. The effect on the force structure is shown in the recapitulation table.

4-9. RECAPITULATION. Table 4-6 provides the additional force structure needed in the Central Region for execution of retrograde missions without imposing a penalty on forward-moving and other FASTALS transportation workloads. The numbers correspond to the number of "dummy" (nationality or type not differentiated) units generated in the FASTALS force structure. The division of the dummy units among US, HN direct, or HN indirect units for mission performance is the subject of Chapter 6, Force Structure Allocation.

Table 4-6. Net Total Truck Companies for Retrograde Operations (PFASS\PFCAE-96)

Mission	LR1		LR2		LR3-5	
	Light	Medium	Light	Medium	Light	Medium
EPW	.02 .02		.02 .02		.03 .03	
NEO					4.62 3.70	
KIA	.15 .08			.18 .09		
Mail	.27 .21		.27 .21	.05 .05	.17 .14	.03 .03
Unit moves		2.74 1.67		5.27 1.63		2.23
Supply & ammo stocks				1.66 .38		1.84
Class VII & IX parts	.02 .04			.10 .13		.01 .01
Total	.46 .35	2.74 1.67	.29 .23	7.26 2.28	4.82 3.87	4.11 .04

Total light truck companies	5.47 4.45
Total medium truck companies	14.11 3.99

CHAPTER 5

THE HEAVY EQUIPMENT TRANSPORTER (HET)

5-1. PURPOSE. To provide expanded analysis on the HET requirements developed in Chapter 2 and provide results of several alternatives based on adjusting maintenance and transportation values within the HET analysis spreadsheet that may reasonably reflect conditions on the European battlefield.

5-2. INTRODUCTION

a. The following results are based on the HET analysis spreadsheet described in Appendix F (see Figure 2-5 for schematic). The spreadsheet combines maintenance profiles of specific tracked vehicles provided by CEM data (Appendix D), AMSAA (Appendix E), and transportation (Appendix F, Annex I). Other tracked vehicles included in the FASTALS Logistics Report but not having a complete data base at AMSAA have been grouped with vehicles having the most similar maintenance characteristics based on AMSAA instructions. The Transportation School provided guidance on aspects of road, rail, and the associated tradeoffs between the two modes to be expected in Central Europe. There was no use of aircraft or watercraft to move damaged tracked vehicles.

b. The base case for both PFCAE-96 and PFASS should be considered the optimum, since it constitutes the set of conditions that allows calculation of the minimum number of HET lifts to support the scenario. Other elements that affect total HET requirements are introduced on an incremental basis to demonstrate the level of effort that may result from a change in a specific variable.

c. PFCAE-96 uses AMSAA statistics applicable for an army on the defensive and continually withdrawing, while PFASS uses statistics reflective of an army experiencing a stabilized FEBA. The difference is that PFCAE-96 has a factor for vehicle abandonment, whereas PFASS maintenance profiles do not.

5-3. THEATER HEAVY TRUCK ASSETS

a. Current FASTALS support requirements for both Central European scenarios include a manual entry for heavy truck companies, TOE 55729L000. The manual entry for PFCAE-96 is 14 companies, and for PFASS it is 10 companies. Heavy truck companies can be either US or host nation direct support units. The value for the manual entry is provided by either the study sponsor or the Transportation School. There are no heavy truck units derived by a FASTALS workload factor. All of PFCAE's 14 companies as well as 8 of the 10 PFASS companies are available at TP1.

b. All heavy truck companies are composed of 24 HETs each.

c. HETs and HET equivalent vehicles are found in other than heavy truck companies. Often they are issued as part of modified TOEs because the unit is not supported by a heavy truck company.

(1) Maintenance units supporting the armor and mechanized divisions usually have a total of six HETs as part of a modified TOE. Separate armor brigades and armored cavalry regiments (ACR) also have an available evacuation capability of up to six vehicles.

(2) Civil and combat engineer units have tracked vehicles which must be evacuated to maintenance or transported to and from work sites. The transport means is normally a flatbed trailer having a lower carrying capability than a HET.

(3) This study will count only true HETs, which are vehicles capable of carrying battle tanks. Engineer transporters are assigned to support organic engineer vehicles and cannot legitimately be considered as available for other missions. Transporters justified by mission and found in engineer units will not be included in the subsequent analysis. HETs belonging to the heavy divisions are considered to be contributory to the total theater requirement for HET companies and offset against the manual entry programmed by the war gamers to dictate the number of HET companies for the scenario. Figure 5-1 compares the total number of HET vehicles available for use that are not in heavy truck companies (division, separate brigade, and ACR trooplist) with the scenario manual entries. The HETs are totaled based on having six HETs per heavy division and six per separate armored brigade and ACR. Additional discussion on this subject is presented in paragraph 6-5, Chapter 6.

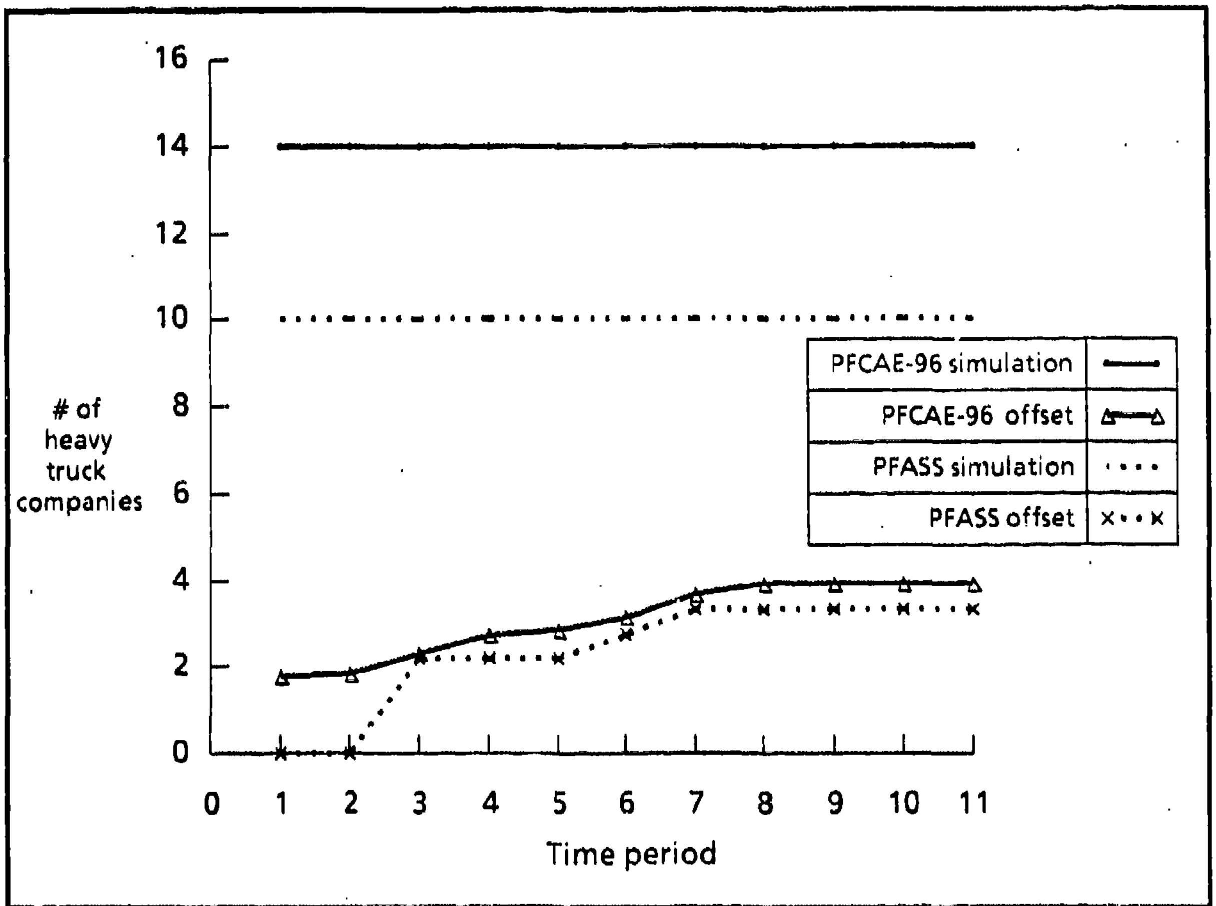

Figure 5-1. Total Heavy Truck Companies - Manual Entry vs Expected FASTALS Trooplist Equivalent

5-4. BASE CASE RESULTS

a. Chapter 2, Table 2-25, shows the requirement for HET lifts for maintenance evacuation and movement of repaired/issued vehicles in 10-day increments. PFASS HET requirements are much lower than PFCAE's for several reasons.

(1) There are significantly fewer combat vehicles in the PFASS scenario.

(2) Analysis of the CEM Logistics Report for each scenario indicates a significant difference in the treatment of vehicle damage within the CEM program. Table 5-1 provides a comparison between vehicles repaired (temp) and salvaged (perm). The decreased rate of salvaged vehicles for PFASS contributes to the reduced requirement for nonproductive HET lifts, i.e., vehicles evacuated to maintenance units and not repaired. The numbers in parentheses for combat loss and noncombat loss add to the 1.00 shown in the total loss column.

Table 5-1. Sample Vehicle Losses as Reported in the Scenario Logistics Report (day 17-20, tank 1), by Scenario

Scenario	Total onhand	Total loss	Combat loss		Noncombat loss	
			Temp	Perm	Temp	Perm
PFCAE-96	2,082	930(1.00)	527(.566)	227(.244)	160(.172)	16(.017)
PFASS	2,248	902(1.00)	565(.626)	157(.174)	168(.186)	12(.013)

(3) The HET spreadsheet analysis is affected by the different salvage distributions provided by AMSAA and the different CEM weapons mixes to reflect the difference between an adversely moving FEBA (PFCAE-96) and a stable one (PFASS). The effect of the different data is additive in nature, both tend to widen the spread between the two scenarios.

b. The AMSAA maintenance distributions have a high percentage of repair at the maintenance CP, organization, and direct support locations. This characteristic reflects the repair as far forward as possible philosophy, since all of these sites are in LR1. For the 23 4-day TPs provided by CEM, the percentage range of HET lifts in the division area varied narrowly from 92.1 percent to 94.3 percent for PFCAE-96. The range was between 95.6 percent and 97.4 percent for PFASS. The very high values indicate that the vast majority of HET units would benefit from a company base positioned in LR1.

c. The spreadsheet analysis also delineated both line and local haul missions. The Transportation School provided line haul versus local haul percentages for each possible HET mission based on AFPDA and adapted for perceived conditions in the Central Region.

(1) The percent of local hauls in PFCAE-96 LR1 varied between 77.65 and 84.40 percent. The PFASS range of 89.26 percent to 92.77 percent shows a higher percentage of local hauls and a narrower range.

(2) The CEM Logistics Report indicates that vehicles in theater reserve (TR) are issued at a constant rate until day 56, at which time the reserves are at a zero balance. This phenomenon affects the local/line haul percentage in LR2-4. The local haul percentage for PFCAE-96 prior to day 56 ranges from 90.84 percent to 94.86 percent, and for PFASS the range is 95.94 percent to 99.66 percent. However, after day 56, the figure is 77.78 percent for both scenarios. The reason for this can be understood by referring to Figure F-3, Appendix F. After day 56, no local hauls are needed from TR to the origin railhead or from the destination railhead to the division support area (DSA). Therefore, the local/line haul ratio becomes constant because the transportation distribution values of the spreadsheet are fixed when vehicles are filtered through the spreadsheet from a single source (combat damage).

d. Transportation School doctrine states that the primary mission of the HET is to transport operable vehicles forward toward the battle. The maintenance evacuation mission is secondary. The HET analysis tracked the relationship between the two missions.

(1) There is no reason to have any forward-moving HET loads in LR1, although nothing prevents an operable vehicle from riding a HET from DS to the CP. Normally, the operable vehicle will be driven forward from unit maintenance or DS by the crew. ETRANS did not count any forward-moving HET workloads in LR1.

(2) Only two maintenance-related possibilities exist for using a HET moving toward the FEBA in LR2-4; a GS-repaired vehicle moves to the DSA, or a depot-repaired vehicle moves to the DSA. Since AMSAA maintenance profiles exclude the depot from whole vehicle maintenance, the spreadsheet always has a zero value for this possibility.

(3) The last possibility for forward movement occurs when theater reserve vehicles are issued. TR vehicles move by rail to the corps railhead serving the DSA. At the DSA, the entire weapon system (vehicle, crew, ammunition, and fuel) is prepared for battle.

(4) The DSA site may or may not be in the proximity of the DS maintenance unit. Some dead time can be expected before the HET is able to arrive at the maintenance locations that have vehicles available for evacuation to GS. The effects of dead time have not been figured into the HET spreadsheet.

e. Figure 5-2 provides the answer to EEA 2, the number of heavy truck companies needed to perform only the maintenance evacuation mission. All forward-moving HET lifts have been removed. Chapter 3, Table 3-18, shows the data used to create the figure. It is evident for PFCAE-96 that the answer of 5.01 HET companies from Table 3-18 is unsatisfactory. The character of the curve indicates that if only five HET companies were available, many vehicles that could have been evacuated and repaired will be left on the battlefield between day 20 and day 60. PFCAE-96 requires between six and eight HET companies depending on the degree of risk assumed. PFASS can evacuate repairable vehicles by dedicating three HET companies to the mission on a full time basis.

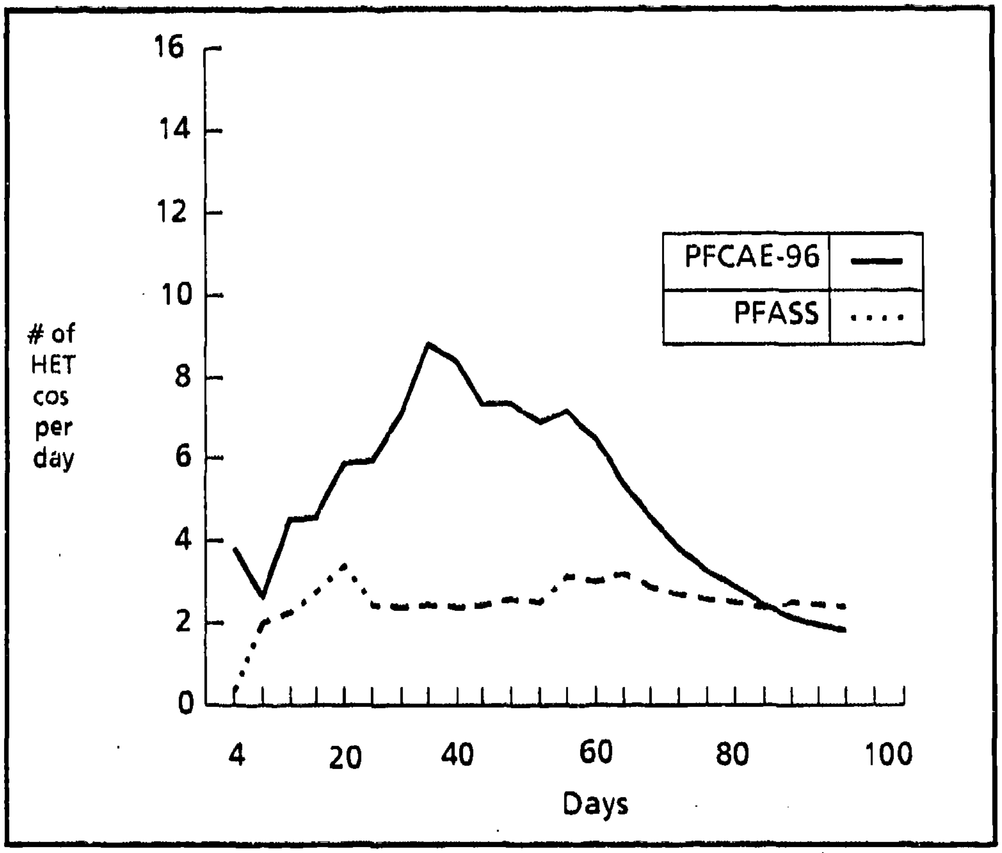

Figure 5-2. Heavy Truck Companies to Support Maintenance Evacuation

f. Figure 5-3 shows the total number of heavy truck companies needed for movements in both directions and reduced by backhauls to the maximum degree possible. After day 56 when TR stocks are exhausted, virtually all of the forward-moving requirements are absorbed as backhauls from the maintenance evacuation requirements. This is understandable, since the only way an operable vehicle can move forward from GS or depot is if the vehicle had been evacuated to GS originally. Values in Figure 5-3 are considered the ETRANS base case.

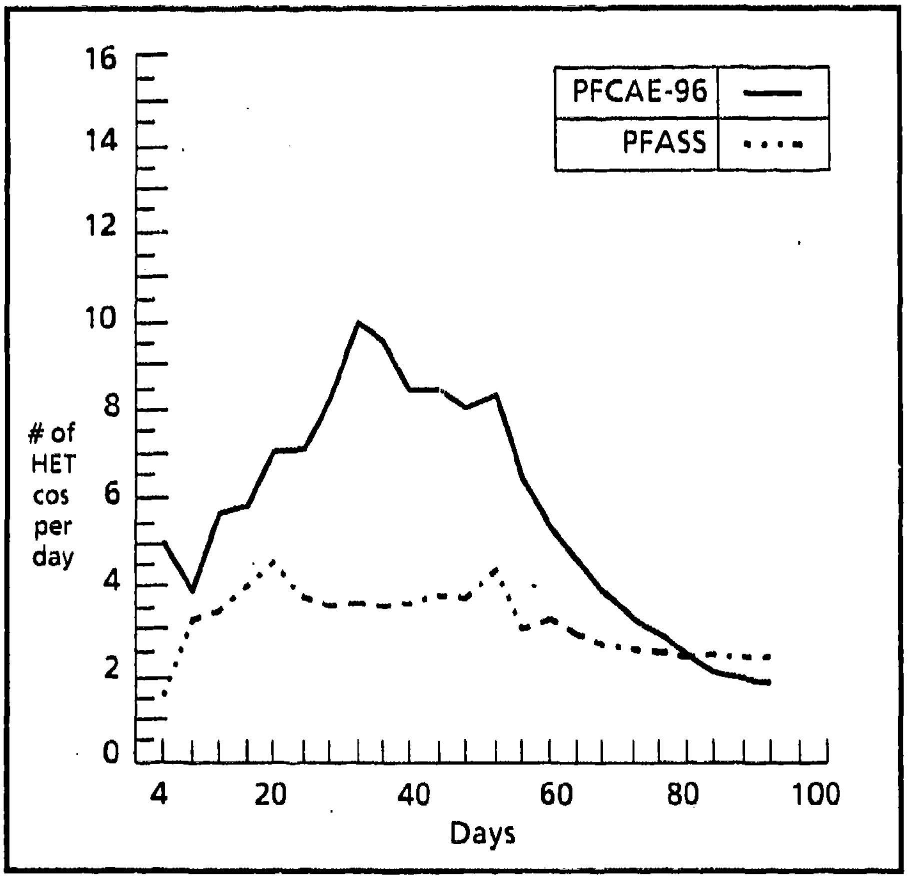

Figure 5-3. Heavy Truck Companies to Support Maintenance Activities - Base Case

g. Figure 5-4 shows the relationship between tanks, armored personnel carriers, and artillery vehicles requiring HET transport. The low requirement for artillery could be indicative of limitations in CEM and the AMSAA data base rather than reflective of the actual number of artillery pieces that need evacuation. The modeling of artillery appears not to have been to the same detail as that for tanks and APCs.

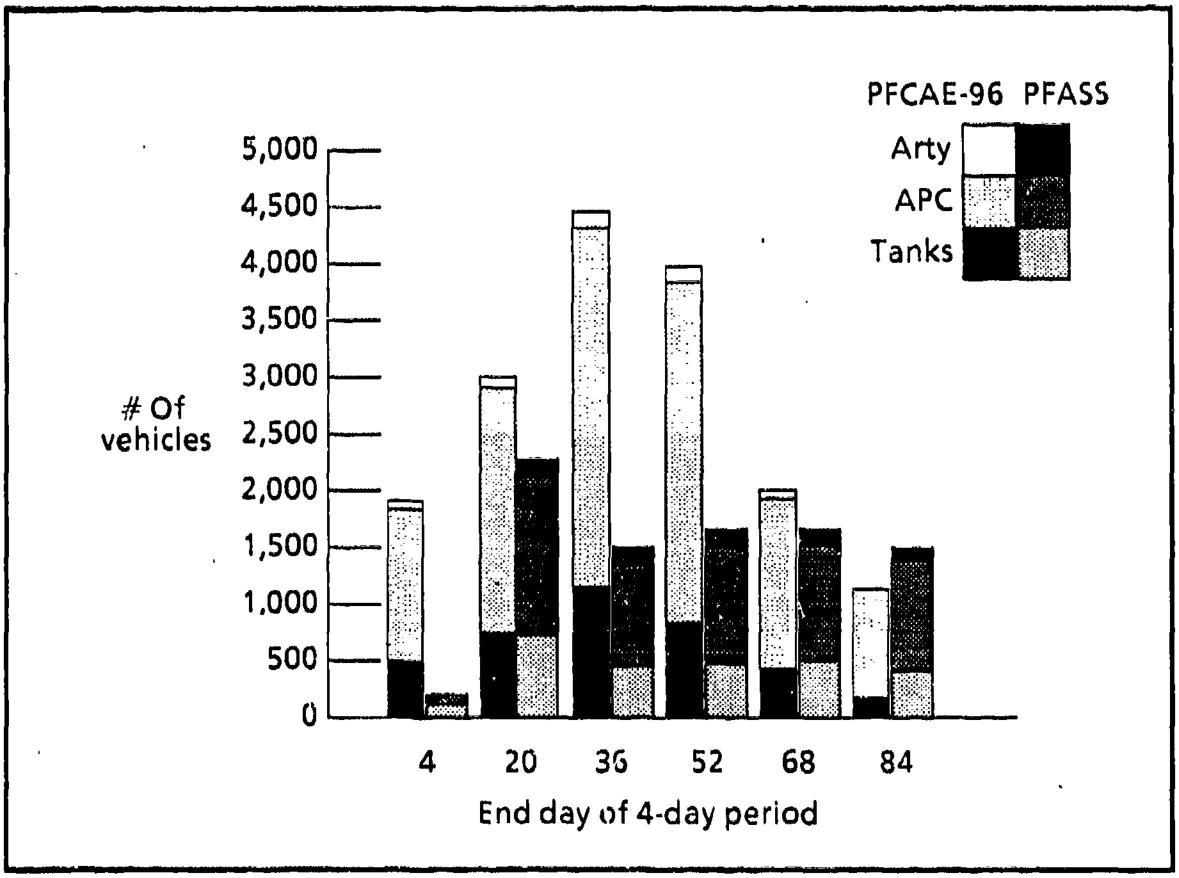

Figure 5-4. Comparison of Armor, APC, and Artillery Lifts

5-5. BASE CASE VARIATIONS. The variations of the base case either increase the workload for heavy trucks or decrease the efficiency of the tracked vehicle maintenance effort. Therefore, all variations result in increasing the requirement for HET lifts. In every case, the effect on PFASS is greater, which is a result to be seriously considered when evaluating the effects of maintenance support alternatives.

a. Maintenance Passback. The sample distributions provided by AMSAA are peacetime-generated forecasts of wartime conditions and are reflected in the base case data. Against a sophisticated foe such as the Warsaw Pact (PFCAE-96) or the Soviet Union (PFASS), the ability to perform maintenance in the forward areas to the degree desired is problematic. A reasonable expectation is that vehicles may be passed back to the next higher maintenance unit at a higher rate than originally forecast.

(1) There are several alternatives for calculating a passback requirement. The chosen method of applying a passback rate that is 20 percent higher than the AMSAA forecast rate is provided in Table 5-2. The 20 percent

reduction in maintenance capability affects all maintenance levels but is limited to temporarily damaged combat and noncombat vehicles. Vehicles that work their way back through the system and are eventually salvaged are not considered. This calculation is a conservative method because it decrements the total workload at each level by 20 percent; there is no cumulative effect of the passback. A cumulative effect is possible if the original workload is decremented by 20 percent and the additional workload imposed by the 20 percent from the lower maintenance level is passed back through all higher levels. The GS profile remains at 100 percent because AMSAA data provides for no depot maintenance, and any vehicle not repaired at GS would be listed as a permanent loss (salvaged).

Table 5-2. Sample Computation of 20 Percent Maintenance Passback Given Base Case Values

	Base case value	Calculation	Result of 20% reduction
Battlefield repair	.060	.060 X .8 =	.048
Repair at maint CP incl battlefield passback	.564	.060 X .2 = .012 + .564 X .8 =	.461

			.509
CP transfer to org	.091	1 - .509 = .491 X .091 / .436 =	.102
CP evacuation to DS	.345	1 - .509 = .491 X .345 / .436 =	.389

	.436		
Org repair	.701	.701 X .8 =	.561
Org pass back to DS	.299	1 - .561 =	.439
DS repair	.857	.857 X .8 =	.686
DS pass back to GS	.143	1 - .686 =	.314
GS repair	1.000		1.000

(2) The passback calculations were done for 20 percent and 50 percent to demonstrate the effect of the AMSAA maintenance profiles. While the 50 percent factor may be too high, it does provide a graphic comparison of the HET requirements even if the "fix far forward" policy is partially unsuccessful. Figure 5-5 shows the results for both scenarios.

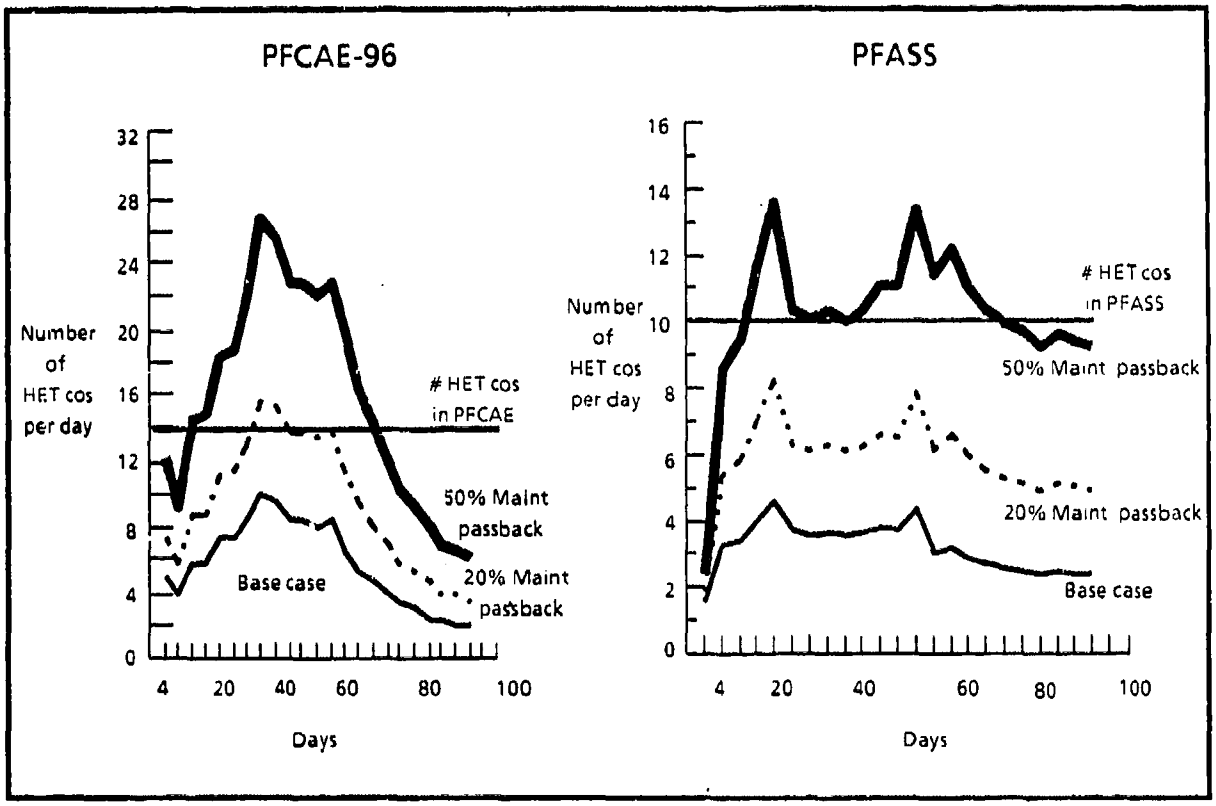

Figure 5-5. Heavy Truck Company Requirements - 20 Percent and 50 Percent Maintenance Passback vs Base Case

b. Reduced Salvage Value. Discussions with AMSAA technicians indicate that of all the values provided in the maintenance profiles, the catastrophic kill (K-kill) value was the most difficult to determine. The AMSAA K-kill percentage of permanent combat damaged vehicles varies between 80 and 88 percent for PFCAE-96 and is 80 percent for all PFASS vehicles. Vehicles not listed as K-kill or abandoned are evacuated to the CP and may subsequently be lifted to organization, DS, or GS maintenance. Figure 5-6 shows the change in HET company requirements if an additional 20 percent of all K-killed vehicles are recovered to the CP. The additional vehicles are then distributed by HET to the maintenance activities in the same ratio as provided by the original AMSAA distribution. Table 5-3 provides a sample calculation.

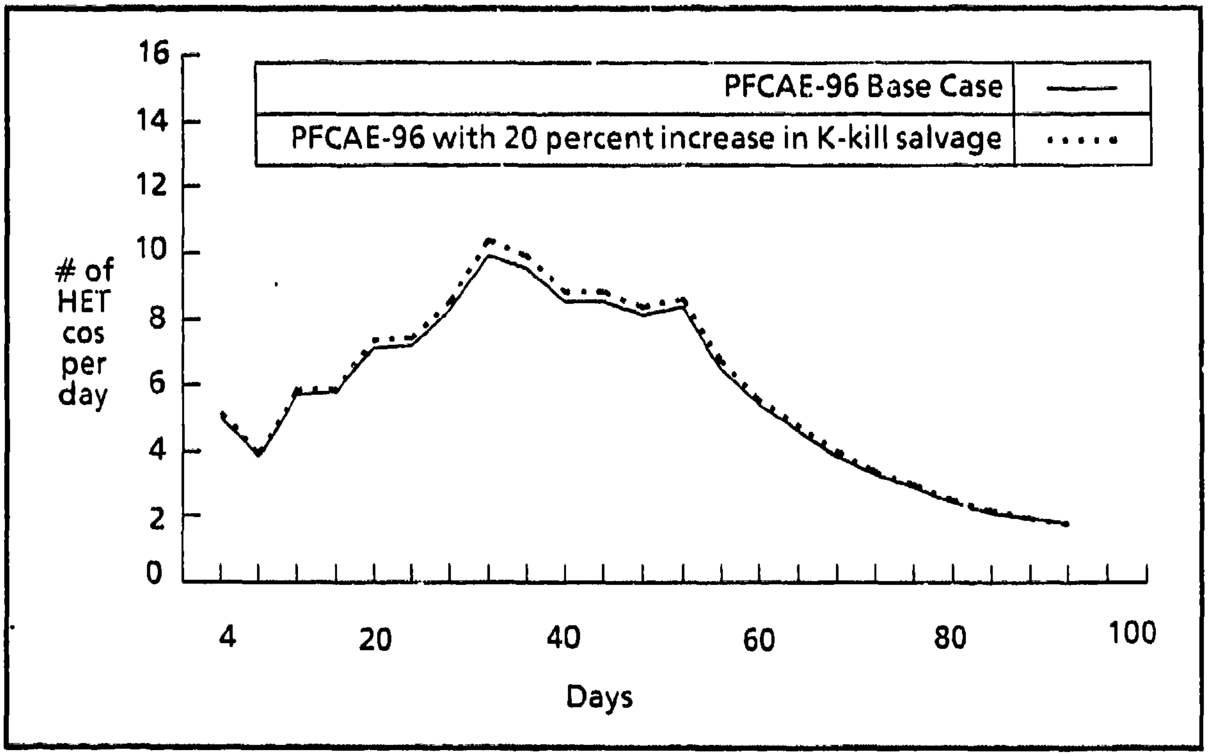

Figure 5-6. Comparison between a 20 Percent Increase in Recovery of K-kill Vehicles vs Base Case

Table 5-3. Sample Calculation for 20 Percent Change in K-kill Value

Original distribution of combat losses (perm)		Calculation of new distribution
Abandoned	18%	No change
K-kill	67%	.67 X .8 = .54; .54 + .18 = .72; 1.00 -.72 = .28
Transfer to org	1%	.01 X .28 ÷ .15 = .02
Evacuation to DS	5%	.05 X .28 ÷ .15 = .09
Evacuation to GS	1%	.01 X .28 ÷ .15 = .02
Salvage at CP	8%	.08 X .28 ÷ .15 = .15
	----	----
	15%	.28
Not recovered	52%	.54 - .28 = .27

c. **Use of Rail.** One of the advantages of the Central Region is a well-developed and defense-oriented host nation rail system. The general perception is that rail will be available from the corps rear through COMMZ; however, there may be circumstances when rail may be capable of going somewhat forward of that point.

(1) The method of testing the effect of not having rail available is to alter the transportation distribution percentages in the HET spreadsheet described in Appendix F. One phenomenon of transportation mode calculations is that the use of rail does not necessarily translate into an automatic reduction of truck use. This occurs because of the accepted definitions of line and local haul, i.e., a single truck can do two local hauls per 12-hour shift while only one line haul can be done during the same time. Distance, speed, transport conditions, or other considerations are not factors. For example, when a tank is moved by rail, it requires a local haul to the origin railhead nearest the origin and another local haul from the nearest railhead to the destination. The two local hauls equate to the one line haul needed when transporting the tank directly from the origin to destination.

(2) Figure 5-7 shows the effect of not using rail. The effect lessens after day 56 when TR are exhausted. The transportation planner on site must evaluate whether HET resources are saved (or wasted) when considering the use of rail.

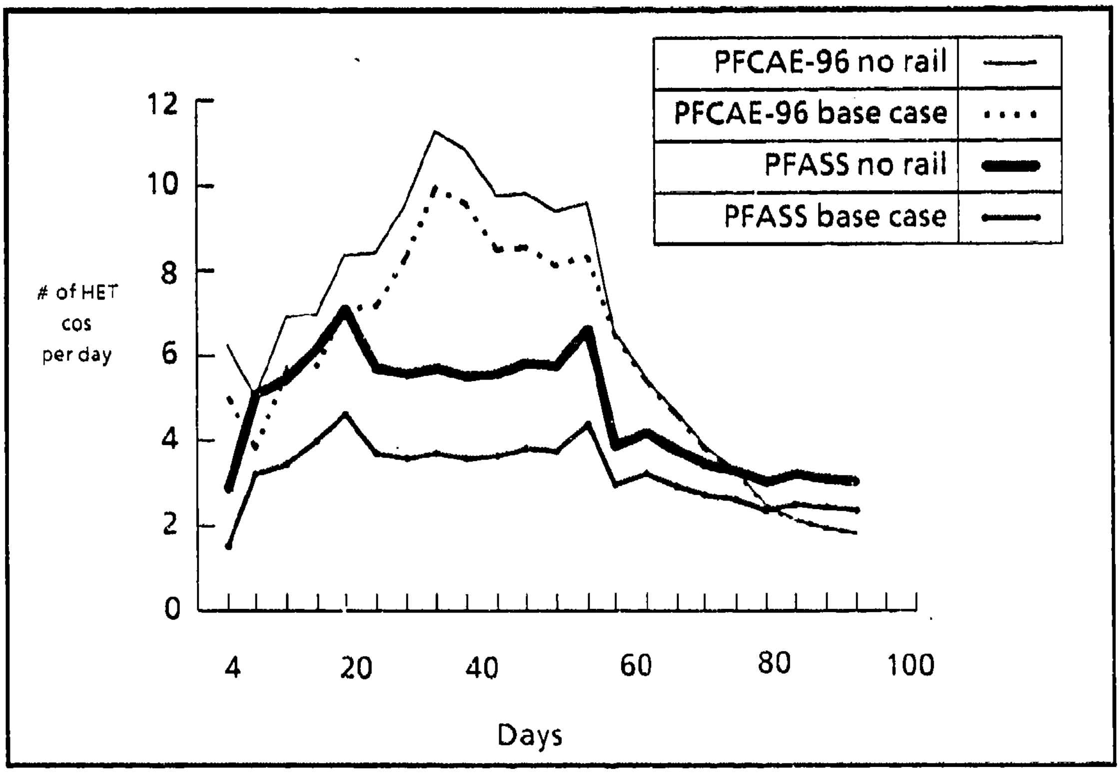

Figure 5-7. Unavailability of Rail vs Base Case

d. Battle Losses. All combat systems will sustain losses during combat. Establishing a HET loss rate has a significant effect on planning for an adequate force structure.

(1) The base case stresses that HETs will be working primarily in LR1. The vehicles they carry are highly sought targets. Working as far forward as the CP and traveling primarily on improved roads make them vulnerable to artillery and air attack. There is only one trailer per tractor, so the prime mover is always with the trailer when waiting to be used or during loading/unloading operations. Destroyed trailers can be as significant as destroyed tractors. When carrying tracked vehicles, HETs are heavy, ponderous objects often unable to take evasive action or advantage of circuitous routing and cover. In LR2-4, the HETs will traverse heavy duty roads easily targeted by the enemy.

(2) There is no well-established attrition rate for HETs. A loss rate for 2 1/2 ton and larger trucks is available, but this figure may not be representative of losses anticipated from the HET mission profile.

(3) To illustrate the effects of combat loss rates on force structure, a loss rate of 1/2 of 1 percent per day and 1 percent per day are shown for PFASS in Figure 5-8. The 1 percent rate is high and atypical of transportation systems, but given the HET mission and an effective enemy effort to disrupt the US maintenance program, it is not an unreasonable rate to use for a reference, indicating the possible results of not having air superiority. The normally expected rate for wheeled vehicles is somewhat less than 1/2 percent per day.

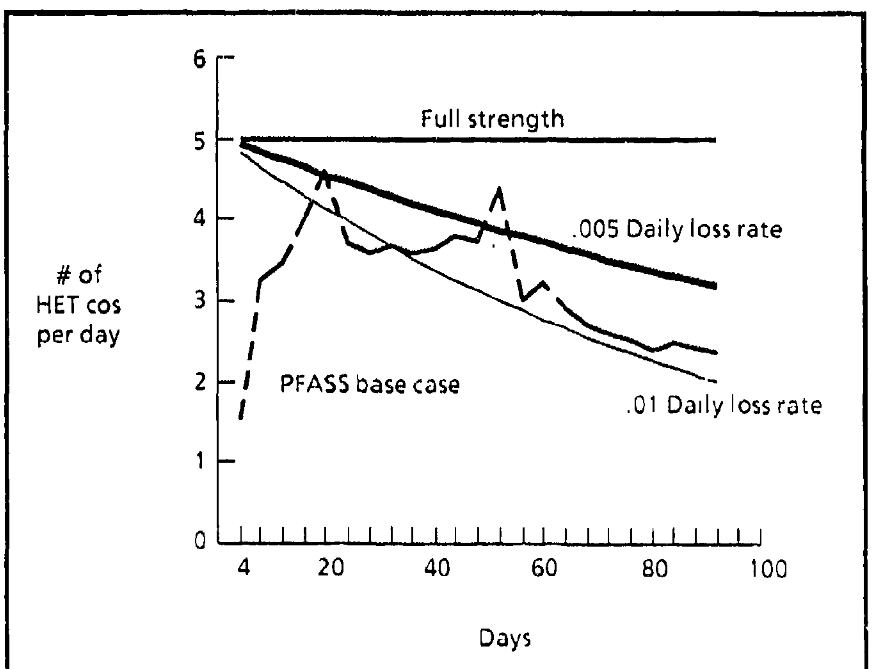

Figure 5-8. Effect of Combat Loss Rates (PFASS)

(4) Five companies could perform the PFASS maintenance workload throughout the war if continuously at full strength; that is, either the HET company does not experience vehicle losses, or the losses are replaced immediately. Four companies would be able to adequately perform most of the time. However, given a loss rate of 1/2 of 1 percent without replacement vehicles, workloads exceed capabilities during a portion of the time between day 40 and day 60. With a 1 percent loss rate per day without replacement vehicles, a portion of the workload cannot be completed for a substantial portion of the war, and a substantial shortfall exists from day 16 onward. A high degree of risk can be assumed by either undersizing the HET force structure initially or by not keeping units at full strength.

(5) It is important to note that the accepted convention for modeling of combat service support vehicles, unlike combat vehicles, is to not calculate a wartime replacement factor to offset combat attrition.

5-6. ESTIMATE OF TOTAL HET REQUIREMENT

a. Figure 5-9 compares the total HET requirements for PFCAE-96 and PFASS. Both graphs show the relative proportions of workload derived from tactical relocation, maintenance related requirements, and unit moves.

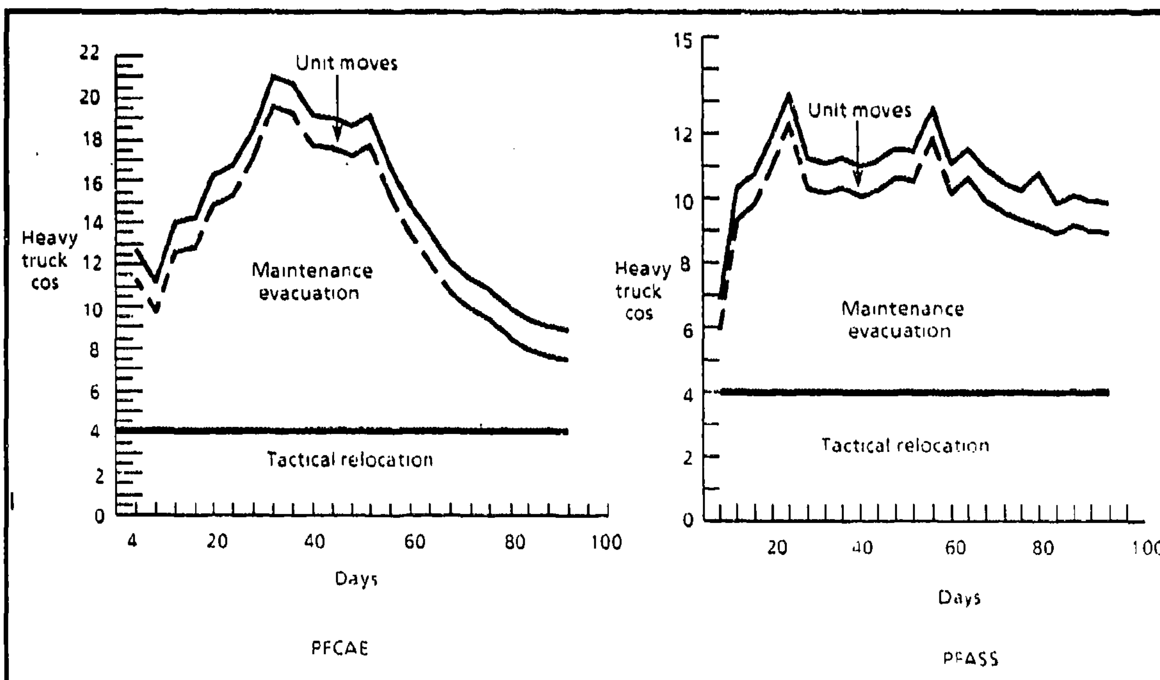

Figure 5-9. Estimated Workload for Heavy Truck Companies

(1) **Tactical Relocation.** The bottom portion represents a single 96 vehicle heavy truck company, as referenced in paragraph 3-14, to fulfill this mission. For charting purposes, it is the equivalent of four 24-truck companies. This is a small theaterwide capability compared to recent

studies. A 96-vehicle HET company per corps is possible. In the 4-corps PFCAE-96 scenario, the dramatic effect on force structure of including 16 HET companies for tactical relocation instead of 4 can be easily visualized.

(2) **Maintenance Evacuation.** This portion also includes HETs needed for ferrying systems forward and taking advantage of backhauls when possible. The effects of a 20 percent maintenance passback is included because it represents a reasonable degree of degradation from best case statistics.

(3) **Unit Moves (tracked vehicles).** The top area represents the requirement generated by the battlefield movement of maintenance units referred to in paragraphs 2-13 and 3-13.

b. No adjustments were made for possible changes in salvage values, rail support, or combat losses.

c. In comparison, Figure 5-10 shows the relationship between the total number of heavy truck companies required by workload in Figure 5-9 and the 1/2 of 1 percent attrition rate for three levels of force structure for each scenario.

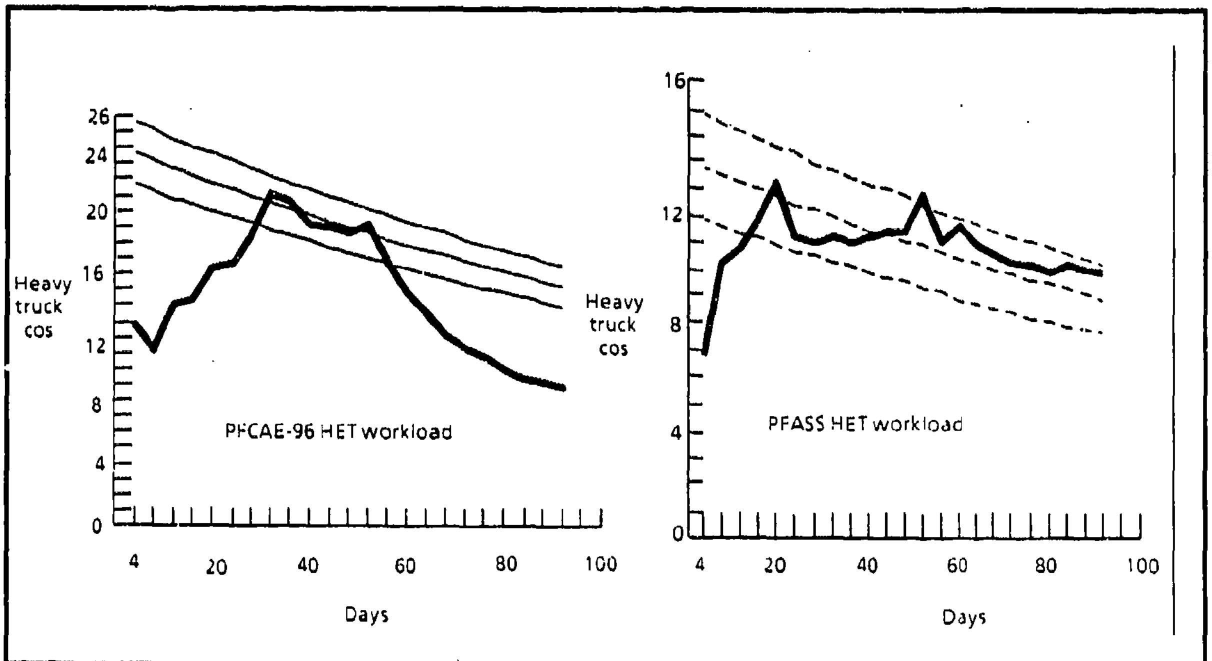

Figure 5-10. Heavy Truck Company Workload vs Attrited Capability

(1) The graphs indicate that if 26 HET companies were available at the start of the PFCAE-96 war, all workloads could be accommodated. Some degree of risk is assumed if only 24 companies were available, and the level of risk is high for TP5, 6, and 7 if 22 companies were available at the start. The PFASS scenario would incur a significant amount of risk if only 14 companies were available; the risk appears unacceptable if 12 HET companies were available.

(2) The attrition curves would step upward very slightly (a reduction in attrition) if HET companies were introduced into the theater after the start of the war. The PFCAE-96 scenario has no CONUS-based HET deployments, but two companies are deployed from CONUS in PFASS.

d. As a matter related to the discussion of HET force structure, Figure 5-11 compares the total ETRANS heavy truck company requirements with the number of companies provided in each scenario. The "combining rule" curve for HETs programmed in FASTALS is provided as a reference to indicate the degree of fill that would have occurred if there was not a manual entry that increased the force structure for HETs in each scenario. The combining rules are based on the existence of heavy divisions, separate armored brigades, and ACRs in the scenario and are discussed in more detail in Chapter 6.

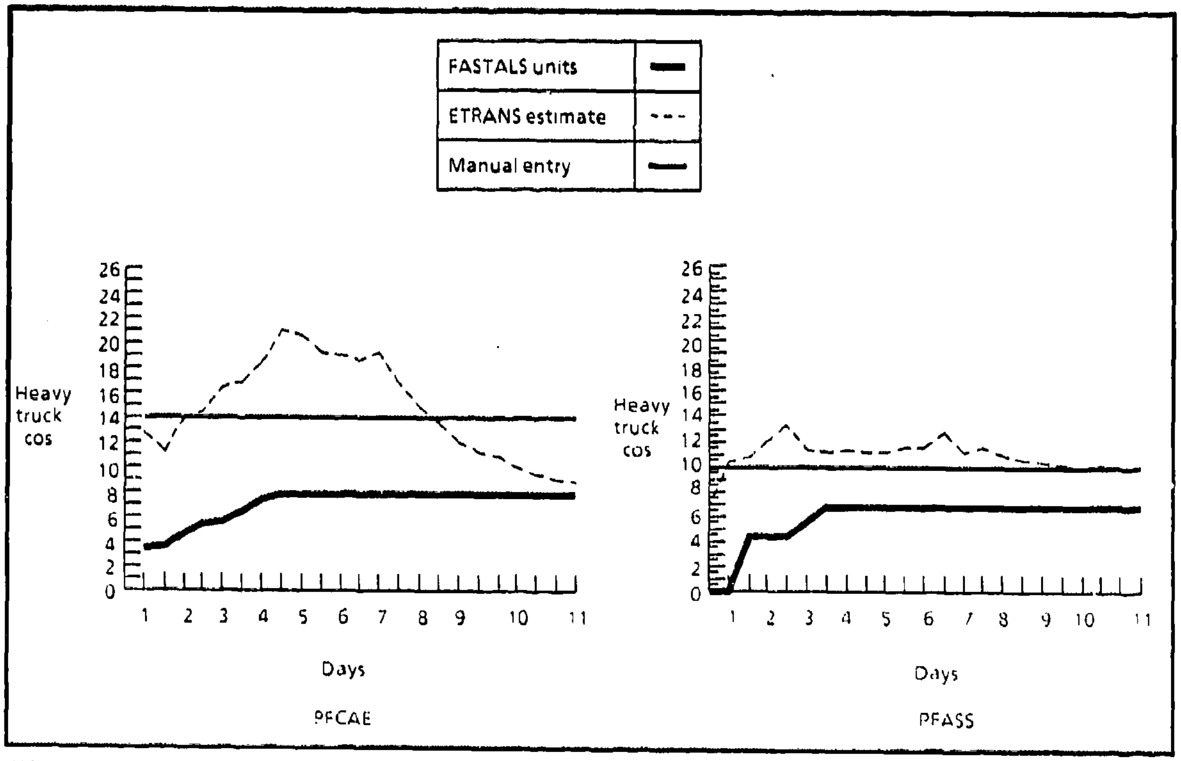

Figure 5-11. ETRANS Estimate versus Manual Entry and FASTALS Combining Rules

5-7. CONCLUSION. Figure 5-11 indicates that the 14 heavy truck companies programmed in PFCAE-96 and the 10 companies programmed in PFASS understated the Central Region's need for HET support. However, when attrition is included (as in Figure 5-10), the requirement estimates are increased in number to that likely to occur during war. The ETRANS minimum estimate is that the PFCAE-96 scenario will require 22 heavy truck companies and the PFASS estimate should be increased to 14. In addition, force structure to perform the tactical relocation mission could further increase the estimate by up to 12 companies for PFCAE-96 and up to 8 companies for PFASS.

CHAPTER 6

FORCE STRUCTURE ALLOCATION

6-1. PURPOSE. To determine how the additional truck company requirements identified in Chapters 4 and 5 should be allocated within the theater.

6-2. INTRODUCTION. Allocation of truck companies in the FASTALS program is determined based on logical region and nationality, i.e., either host nation or US. First, a determination must be made concerning the location of the transport units required for retrograde transport. Second, given the location, a choice of the appropriate unit to perform the mission is made from among a US TOE unit, a host nation direct support unit, or host nation indirect support transport resources.

6-3. PROTOTYPE OR "DUMMY" FORCE STRUCTURE. Table 6-1 provides the number of retrograde truck companies required after integration with the light, light-medium, and medium trucks companies moving cargo forward. Also shown is the number of HET companies determined in Chapter 5 that are needed to provide adequate support.

Table 6-1. Net Total Truck Companies for Retrograde Transport

Type truck	PFCAE-96			PFASS		
	LR1	LR2	LR3-5	LR1	LR2	LR3-5
Light (55718L200)			4.82			3.87
Light-medium (55719L100)	.46	.29		.35	.23	
Medium (55727L100)			4.11			.04
Medium (55728L100)	2.74	7.26		1.67	2.28	
Heavy (55729L100) (Total)			22.00			14.00

6-4. FASTALS FORCE STRUCTURE

a. Truck company requirements can be filled by either a US Army unit, a host nation direct (HND) unit, or host nation indirect (HNI) trucks.

(1) US Army units include those that are forward-stationed and those that deploy to the Central Region either prior to hostilities (TP2) or subsequent to D-day (TP3-11). All combat and combat support units in LR1 are US units. The majority of combat service support in LR1 is also expected to be performed by US units.

(2) HND units are structured by the host nation to have approximately the same size, equipment types, and mission capabilities as their US counterparts. These units have a relationship of "obligatory cooperation" to their supported units. Some of the HND units are expected to perform their mission in LR1, but a higher proportion is expected to be in LR2 and 3. The PFCAE-96 trooplist explicitly shows only one HND unit (a conventional ammunition unit) in LR1. HND truck companies are characteristic of LR2 and 3, but no unit is listed in the FASTALS force structure listing for LR4. The number of units is considered fixed for short-term planning based on US/HN agreements.

(3) HNI support units are diverse trucks and civilian drivers retained by the host nation for military service in times of national emergency. HN authorities assign assets based on US requests and forecasts of US needs. A small number of HNI units performs transportation, maintenance, and quartermaster functions in LR2. However, they are more common in LR3 and 4.

b. Except for light-medium and heavy truck companies, the FASTALS program accumulates tonnage and calculates transportation force structure based on internally-generated workloads that simulate transportation missions. FASTALS combines requirements to generate a generic "dummy" truck unit. Truck companies are accumulated by specific LR, but for analysis purposes, the companies will be shown as a Central Region total by TOE designation and TP. The decision to allocate US, HND, or HNI support force structure to offset a dummy unit rests on several scenario-dependent factors.

(1) To fulfill the FASTALS-generated dummy requirements for transportation units in the Central Region, the preferable hierarchy is HND, HNI, and US TOE units.

(a) The US and HN formally negotiates and agrees on the number of HND units to be formed and obligated to support US transport requirements. The number of units is relatively fixed and is a manual entry in FASTALS. The HND support units are usually available in TP1.

(b) HNI units attempt to fill the gap between HND support units and total requirements to the extent possible based on war plan expectations, fully and partially planned requests from the US, and bilateral agreements. They become available based on forecasts of need and the ability of the HN to organize and deploy them.

(c) Forward-deployed US units are used to complete force structure requirements. If those forces are insufficient, additional US units are deployed from CONUS to complete the total requirement to the degree possible based on the availability of units and competing needs in other theaters.

(2) The identification of force structure requirements versus the availability of units of a particular type to fulfill them may lead to imbalances among FASTALS regions. LR3 may be short units needed to offset dummy units that excess units in LR4 may satisfy. It is also possible to have excess US units when available HND and HNI units exceed total requirements. Internal FASTALS rounding routines, unit rounding rules, and needs of the sectors can also cause imbalances. Overall, shortages may occur if the US is unable to deploy enough units of the correct TOE to make up a shortfall not filled by HN units.

6-5. LIGHT AND LIGHT-MEDIUM TRUCK COMPANIES

a. The light truck company (TOE 55718L200) is a FASTALS workload-generated unit based on four workloads: #8, STON ALOC Class IX Issue/Day; #46, STON Non-ALOC Class IX Issue/Day; #23, STON General Supplies Issue/Day; and, #25, General Supplies Stock Change/Day. Light trucks can be in LR2 through 4, but the current automated force structuring process does not generate any nondivisional light truck company requirements for LR1. Using PFCAE-96 as an example, only three dummy light companies were generated for the theater by the workloads, apparently to be used around aerial ports of debarkation (APODs) and supply depots where Class IX and other supplies are handled.

b. There is no FASTALS workload to capture transport of NEO evacuees after they are at the NEO collection points near the APODs. The minimum requirement is 4.62 light truck companies for PFCAE-96 and 3.70 for PFASS. This constitutes 96 percent of the total light truck requirement in Table 6-1. Military trucks are not the preferred vehicle; civilian buses are needed. Therefore, the appropriate response is for HNI units to be tailored to the NEO mission. Peacetime planning and submission of standard NATO Agreement 2165 forms will negate the need for using tactical vehicles.

c. In PFCAE-96 there are 20 light-medium truck companies (TOE 55719L100) in the theater, all of which are assigned to the corps for support of the divisions. The light-medium truck companies are allocated based on the existence rule of one company per division support command in the theater. Interestingly, there is no provision for light-medium truck support to the separate brigades.

d. Eighty-three percent of the vehicles in the light-medium truck company are light trucks that can satisfy all the requirements normally performed by the light truck company. The question becomes whether the light truck retrograde missions can legitimately be performed by the light-medium truck company in LR2. Mail is the primary mission. EPW, KIA, and Class VII and IX parts contribute other small but measurable workloads. The need for specialized trucks has been discussed in paragraphs 2-8 and 3-8; however, it is reasonable to believe that the .02 of each light-medium truck company required could be devoted to these LR1 and 2 functions, if necessary, without significantly affecting other missions (average PFCAE-96/PFASS requirement is .41 truck companies in LR2 ÷ 20 light-medium truck companies = .02). Mail workloads should be added into the calculations for light and medium truck workloads.

6-6. MEDIUM TRUCK COMPANIES

a. The identity of the two types of medium trucks is easier to separate than the sources of light trucks. The theater (LR3-5) is served by TOE 55727L100 that has 40-foot trailers and the corps (LR2) by TOE 55728L100 which has 28-foot trailers. Standard transportation doctrine was followed for PFCAE-96 and PFASS: Workload 18 requirements in the corps are satisfied by the corps medium truck company only, and Workload 18 requirements in the theater are satisfied by the theater medium truck company.

b Workload 18, 1,000 STON Hrs Dry Cargo and Unit Equipment/Truck/Day, is the unit generator for medium trucks. Table 6-2 shows the quantities of dummy medium truck units for each scenario that were added to the force structure for each time period.

Table 6-2. Scenario-generated "Dummy" Force Structure Additions by Time Period

Scenario	Time period									
	1	2	3	4	5	6	7	8	9-11	Total
PFCAE-96										
TOE 55727L100	15	0	7	5	8	4	2	1	0	42
TOE 55728L100	5	0	12	7	2	0	3	2	0	31
PFASS										
TOE 55727L100	0	2	20	5	2	9	0	0	0	38
TOE 55728L100	0	0	14	1	0	7	2	0	2	26

c. Comparing requirements to availability, Table 6-2 (requirements) with Table 6-3 (availability), shows that PFCAE-96 is short six companies of TOE 55728L100 in LR2 but excess six companies of TOE 55727L100 in LR3-5. PFASS has the identical number of companies in LR3-5 but has an excess of two companies onhand in LR2.

Table 6-3. Available Medium Truck Companies

Scenario	Time Period									
	1	2	3	4	5	6	7	8	9-11	Total
PFCAE-96										
TOE 55727L100										
HN direct	9	0	0	0	0	0	0	0	0	9
HN indirect	0	1	9	6	4	0	0	0	0	24
US	0	7	3	1	1	0	2	1	0	15
										48
TOE 55728L100										
HN direct	15	0	0	0	0	0	0	0	0	15
HN indirect	0	0	1	1	0	0	1	0	0	3
US	0	0	2	2	2	0	1	0	0	7
										25
PFASS										
TOE 55727L100										
HN direct	9	0	0	0	0	0	0	0	0	9
HN indirect	0	1	9	2	1	6	0	0	0	19
US	0	1	5	0	1	3	0	0	0	10
										38
TOE 55728L100										
HN direct	15	0	0	0	0	0	0	0	0	15
HN indirect	0	0	0	0	0	2	0	0	0	2
US	0	0	6	0	0	2	0	2	1	11
										28

(1) The most reasonable solution to the PFCAE-96 imbalance indicated above is to have 6 of the 15 US theater truck companies transfer to LR2 and operate as corps medium truck companies. This is sensible, because the HN is already supplying 15 HND and 3 HNI companies to the corps. However, this overweighting of HN assets may result in delays due to trailer incompatibility in LR2.

(2) Referring to Table 6-1 for PFCAE-96, ETRANS has identified that an additional 2.74 medium truck companies are needed to support LR1 and 7.26 companies to support LR2. There is little basis to determine an optimum result except to maintain a balance between the HN units and US units so that the effects of trailer incompatibility are reduced to the maximum degree possible.

generated the requirement and identify the type company most compatible with the mission.

(a) Unit moves accounted for a total of 8.01 of 10.00 truck companies needed. That portion of unit moves occurring in LR1 is most appropriate for the US (2.74 truck companies rounded to 3).

(b) The movement of supplies in LR2 is a mission easily accommodated by HND units (1.66 truck companies rounded to 2).

(c) The remaining five companies could be divided in half, but remembering the preference for HN over US units, a three HND to two US split is reasonable. The end result is five HND and five US corps medium truck companies.

(3) There are 4.11 theater medium truck companies needed in LR3-5. Table 4-6 indicates that approximately half the workload was for moving supplies and the other half for unit moves. Negotiating with the host nation for an additional two HND for the unit moves and two HNI truck companies for the supplies is a reasonable solution.

(4) PFASS needs an additional 1.67 medium truck companies for LR1 and 2.28 for LR2. The majority (84 percent) of the requirement was generated by unit moves. Using the logic applied to PFCAE-96 above, the LR1 requirement should be filled by US units (1.67 truck companies rounded to 2). As there are already 2 medium truck companies in excess in LR2, they can be used to fill the requirement for 2 of the 4 additional companies needed for the retrograde mission (2.28 truck companies rounded to 2).

(5) Table 6-4 summarizes the differences in the FASTALS medium truck company force structure shown in Tables 6-2 and 6-3.

Table 6-4. ETRANS Distribution of Retrograde Medium Truck Companies

Scenario	FASTALS generated	Add/subtract	ETRANS distribution
PFCAE-96			
TOE 55727L100			
HN direct	9	+ 2	11
HN indirect	24	+ 2	26
US	15	- 6	9
TOE 55728L100			
HN direct	15	+ 5	20
HN indirect	3	-	3
US	7	+ 6 & + 5	18
PFASS			
TOE 55727L100			
HN direct	9	-	9
HN indirect	19	-	19
US	10	-	10
TOE 55728L100			
HN direct	15	-	15
HN indirect	2	-	2
US	11	+ 2	13

6-7. HEAVY TRUCK COMPANIES. Unlike light and medium truck companies which are computed by the FASTALS Model, heavy truck companies are controlled by the wargame players.

a. Table 6-5 indicates that all 14 PFCAE-96 heavy truck companies are forward-deployed (available in TP1). (Of the 14, 8 are HND, and 3 of the HND companies are the only ones in LR3.) PFASS is different. All eight HND are immediately available for use in LR2 and 3, but the only two US companies in the scenario will arrive in TP3 and 7. There are no HNI heavy truck companies in either scenario.

Table 6-5. Manually Entered Heavy Truck Companies in FASTALS

Scenario	Time period									
	1	2	3	4	5	6	7	8	9-11	Total
PFCAE-96										
LR2 HN direct	5									5
LR3 HN direct	3									3
LR2 US	6									6
										14
PFASS										
LR2 HN direct	5									5
LR3 HN direct	3									3
LR2 US			1				1			2
										10

b. The FASTALS combining rule for heavy truck companies is to authorize .5 company for each armor and mechanized division and .167 for each separate armor brigade or ACR. Using that criteria, PFCAE-96 force structure justifies a maximum of 6.5 companies to support the heavy divisions and 1.33 companies for the armor brigades and ACRs. The remaining 6.17 heavy truck companies are added by the wargame players. PFASS uses the same combining rule and justifies a maximum of 5.5 for the heavy divisions and 1.17 for separate brigades and ACRs. The remaining 3.33 heavy truck companies are added by the players.

c. The relationship between the FASTALS heavy truck company combining rule and the PFCAE-96/PFASS heavy truck company quantities is shown in Figure 6-1.

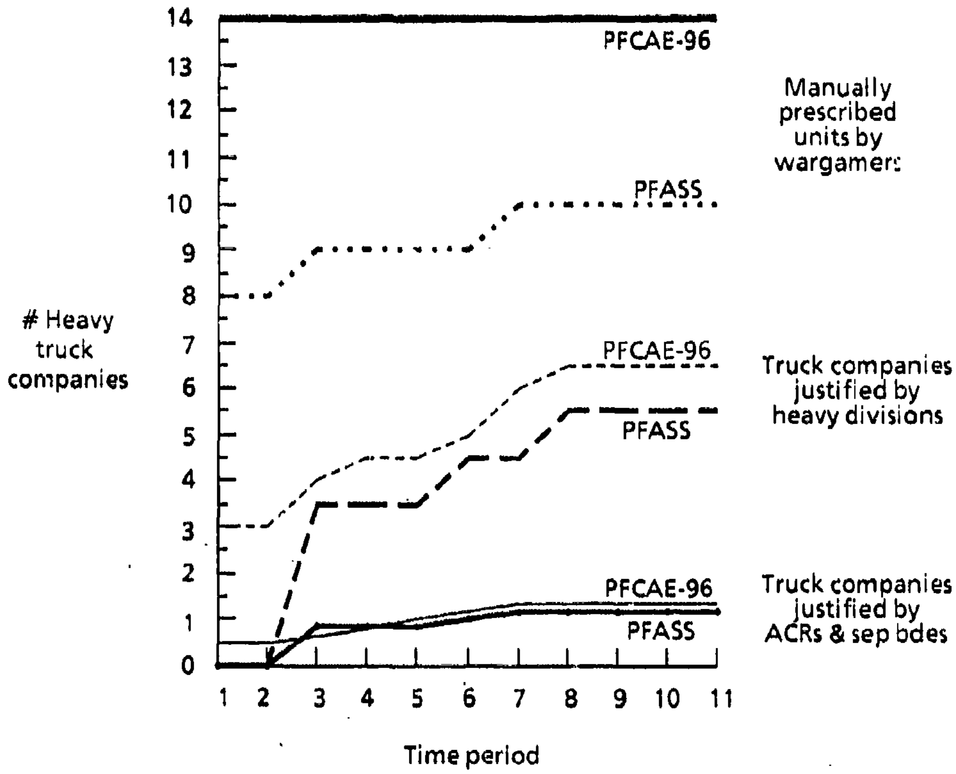

Figure 6-1. ETRANS vs FASTALS Heavy Truck Companies

d. Heavy truck operations are much different than those of medium trucks. The cargo is usually a single vehicle instead of breakbulk loads or containers. There is only one trailer assigned to a tractor, whereas a medium truck will normally exchange trailers several times a day. The heavy truck has a winch so that it is generally self-sustaining. Origins and destinations are normally restricted to maintenance locations and units.

(1) The characteristics of heavy truck operations make it difficult to isolate areas of advantage for US or HND units. The trend appears to be for the US to equip HN military model units probably for the very reason that there is no comparative advantage.

(2) The ETRANS analysis of HET operations indicates that the vast majority of lifts will be in LR1 as far forward as the CP. Normally, HN support force structure declines in forward LRs. That rule cannot apply if the HN is to contribute substantially to the mission.

(3) The tactical relocation mission may be performed primarily in LR2. The paramilitary German Çivilian Service Center (formerly Civil Labor Group) drivers are an example of the excellent support that can be expected from transportation personnel in German direct support units; no advantage is evident by choosing using either US or HN drivers for this mission.

e. PFCAE-96 HET requirements peak during TP5-7. A force of 22 heavy truck companies is below the highest requirement but is a reasonable value considering that some force structure smoothing can be expected.

(1) During TP3, 12 heavy truck companies are adequate. The six US companies forward-stationed and six of eight of the HND companies identified in the force structure are sufficient.

(2) The requirement builds to 22 quickly in TP4-5. Unless additional companies were in prepositioned materiel configured to unit sets (POMCUS), the US would be unable to respond to the requirement in time to participate during the time of greatest need.

(3) For study purposes, assume two additional US companies are in POMCUS and the remaining six are HND available in TP4-5.

f. PFASS shows that the two US units are not available at TP1. One comes on duty during TP3, and the second is delayed until TP7. A total of 12 companies is needed early in the scenario. These should be either HND or forward-deployed US companies. A split of 11 HND and the single US company available at TP3 is reasonable. Two more are needed by TP7, a requirement which could be filled by deploying US companies.

6-8. ASSOCIATED FORCE STRUCTURE

a. When US or HND companies are explicitly (externally) added to or subtracted from force structure, FASTALS is programmed to automatically adjust other command or support units. These could be generated based on population or span of control criteria. For example, when 2 US and 2 HND heavy truck companies are added to PFASS to bring the original 10 companies to the ETRANS suggested level of 14, 8 other types of units were also increased, as listed in Table 6-6.

Table 6-6. FASTALS-generated Units (PFASS)

Activity	Description	Strength
Units explicitly added	2 HND Heavy Truck Cos	304
	2 US Heavy Truck Cos	304
Total		608
Additional units added	1 HHD Petroleum Supply Bn	58
	1 HNS General Supply Co	0
	1 US Heavy Equip Maint Co	243
	2 US Trailer Transfer Point Dets	32
	1 US HHD Motor Transport Bn	50
	1 US Med Truck (Petrol) Co 5000GAL	177
	1 US Court Martial Defense TM	5
Total		565

b. Table 6-7 provides a synopsis of the force changes resulting from the net truck company additions to each scenario. Included is the change in net strength due to truck company additions and the net strength increases for ancillary units composed by the FASTALS Model to support the truck company additions. The HNI units do not receive support from US units and are counted as having zero strength. The light truck companies are included in lieu of civilian buses, the preferred mode of transportation for NEO participants.

Table 6-7. Total FASTALS Force Structure Changes

Unit description	PFCAE-96		PFASS	
	Number	Strength	Number	Strength
HND Light Truck Co	0		0	
HNI Light Truck Co	+5	0	+4	0
US Light Truck Co	0		0	
HND Medium Truck Co	+7	+1,337	0	0
HNI Medium Truck Co	+2	0	0	0
US Medium Truck Co	+5	+955	+2	+382
HND Heavy Truck Co	+5	+760	+2	+304
US Heavy Truck Co	+3	+456	+2	+304
Subtotal		3,508		+990
Transportation related units: trailer transfer points, HHD transportation battalions	+10	+200	+17	+259
Nontransportation support units: medical, quartermaster, legal, ordnance, personal services, firefighting	+5	- 86	+16	+1,122
Subtotal		114		1,381
Total		3,622		2,371

c. The effects of the added truck companies on each scenario are unpredictable. Compared to PFASS, the addition of 3.5 times the transportation truck company force structure (3,508 versus 990) strength to PFCAE-96 results in lower end strength for transportation-related units (200 versus 259) and reductions of nontransportation support unit strength (-86 versus 1,122).

d. EEA 3 asks what additions to US wartime force structure are necessary to execute retrograde requirements. Table 6-7 provides the answer: five medium and three heavy truck companies for PFCAE-96, and for PFASS two medium and two heavy truck companies.

6-9. CONCLUSION. This study identifies a needed increase in transportation force structure for light, medium, and heavy truck companies for both scenarios. HN light trucks (buses) are needed to support NEO, the medium trucks for unit moves and backhaul of supplies, and heavy trucks for tactical relocation, unit moves, and maintenance evacuation. Increases for truck companies in PFASS are relatively small but require a larger amount of collateral force structure. Large increases in truck companies for PFCAE-96 require little collateral force structure.

CHAPTER 7

CAUSES FOR FORCE STRUCTURE ADDITIONS

7-1. PURPOSE. To provide a review of the underlying factors of the force structure increases identified in Chapters 4 and 5.

7-2. INTRODUCTION. This chapter develops EEA 4, "What additions, if any, to transportation force structure are needed to support retrograde missions? What are the factors that affect quantification of these additions?"

a. Factors have been divided into transportation related and all "other" nontransportation related issues. Factors that appear to exert the greatest influence are highlighted. Attention is also given to the differences between PFCAE-96 and PFASS that affect force structure considerations for each scenario.

b. Each retrograde mission that generated additional force structure requirements is addressed. Medical evacuation, captured materiel, denial operations, and strategic materials generated no requirements and are not separately addressed.

c. The single greatest reason for identifying force structure additions throughout the study is the fact that the current transportation force structuring process as implemented in the FASTALS Model has no mechanism to track and accumulate retrograde workloads.

7-3. MAJOR CAUSES FOR FORCE STRUCTURE REQUIREMENTS

a. Enemy Prisoners of War. A very small workload for light trucks in LR1, 2, and 3-5 was identified.

(1) Transportation Causes. No atypical transportation factors were noticed. Workloads in LR1 were low, in part because unit vehicles performed part of the mission.

(2) Other Causes. Lack of offensive action in both scenarios contributed to the low workload. Scenarios designed to anticipate an offensive must be able to accommodate a larger EPW transportation requirement that may increase exponentially as the offense gains momentum.

b. Noncombatant Evacuation Order (NEO). No transport requirements are developed or required for LR1 and 2. An extremely large, somewhat undefined, workload exists in LR3-5.

(1) Transportation Causes. The military community evacuation plans may be designed on the premise that eligibles will be ultimately transported by air to CONUS. NEO eligibles will be the second priority for CONUS movement, coming after medical evacuees. Dispersion of NEO eligibles is needed when in the vicinity of the APOEs so that an opportunity for the enemy to inflict needless casualties is reduced. Evacuees will return to CONUS on aircraft that transport incoming military personnel. Additional aircraft will probably be needed.

(2) Other Causes. Political considerations may cause the situation to deteriorate to the degree that the concentration of NEO personnel at APOEs will be more than can reasonably be handled by current plans. The problems are compounded for PFASS. The opportunity for more Americans to be touring in newly freed countries gives more cause for concern. A lessened commitment of US forward-stationed troops to NATO results in less help being available initially, and the help that is available may be quickly overwhelmed. Host nation support needs to be well planned, sufficient, and without reservation.

c. **Killed in Action.** A small number of light trucks in LR1 and medium trucks in LR2 is required.

(1) Transportation Causes. No transportation problems are noteworthy. Because of the nature of the cargo, truck and trailer loads will be severely below the standard planning factor tonnage.

(2) Other Causes

(a) KIA should be proportional to combat intensity. A scenario with intense combat periods will generate peak workloads. Because PFCAE-96 and PFASS were not offensive in nature, KIA were restricted to friendlies. A FEBA moving westward will reduce workload as more KIA become missing in action. The reverse is also true. A FEBA moving toward the east will maximize the KIA versus missing in action (MIA) ratio.

(b) A forward moving FEBA will pass dead enemy and civilians that may need to be evacuated to prevent potential health hazards. Burial may be quicker in this instance but may not conform to national desire. An argument for relooking the medical evacuation mission can be made for this reason. The offense can place an additional load on ambulance units that may be obligated to evacuate wounded enemy and civilians found in liberated territory.

d. **Mail Transport.** The total force structure accumulated to less than one company of trucks spread throughout all LRs and all sectors of the theater.

(1) Transportation Causes. The FASTALS program contains no explicit provisions for the transport of mail moving in either direction. Sufficient force structure needs to be added to satisfy mail transport in both directions and to accommodate its unique character. While a pounds/man/day factor could be used (added) to generate additional common user transportation requirements, this would not address the "unique character" aspects. Issues mentioned in Chapters 2 and 3--security, origins and destinations, and routing--are not compatible with transportation light and medium truck operations.

(2) Other Causes. Soldiers engaged in battle will not write many letters, but that has little relationship to the quantity of mail moving forward. Mail is expected to be directly proportional to troop strength.

e. Unit Moves. The transportation force structure required for unit moves is more than all the other retrograde missions combined. PFCAE-96 required a total of 10.24 medium truck companies in all LRs. PFASS needed 3.30 truck companies in LR1 and 2.

(1) Transportation Causes. Unit moves are expected to be trailer-intensive; however, no factor for this characteristic is included in the calculation of medium truck companies. Most unit move tonnage is expected in LR1 and 2. This is likely to result in trucks to be loaded less efficiently because of "hand loading" and the expected requirement for a "door to door" move instead of operating through TTPs. Increased dead time can be expected, as few opportunities for backhaul may exist from the new unit location. Backhauls that may exist will be three- and four-point missions. The estimates are likely to be low, since this study intentionally avoided overstating the results of the analysis. The current transportation force structure process (FASTALS) does not consider transportation needed to move units forward other than for initial unit deployments. The requirement for subsequent unit moves is widely recognized, but the method of execution is neglected. Until changed, this could result in severe understatement of transport requirements for scenarios that are offensive in nature.

(2) .Other Causes

(a) FEBA movement is the overwhelming factor. An adverse change causes a critical "move it or lose it" situation. Positive FEBA movement allows some flexibility in timing for forward movement. The problem is that moving units forward does not allow for the efficiencies of backhauls so that overall truck requirements are higher. PFASS, having a FEBA that oscillates very slowly, generates as small a unit move requirement as can be reasonably expected.

(b) Lack of friendly air superiority and effective enemy intelligence activities will increase the frequency of relocations. No significant work on this subject is available in the TRADOC logistic community.

(c) Determining the actual amount to be moved is guesswork at best. Data to support analysis is near nonexistent, and the transport requirements will fluctuate proportionally in the direction of the nonmobile unit weight estimates.

f. Supply and Ammunition Stocks. The requirement for PFCAE-96 is for more than 3 medium truck companies spread throughout LR2-5, while PFASS needed only .38 medium truck companies in LR2.

(1) Transportation Causes. The reasons provided above for unit moves also apply to supply and ammunition stock moves. Corps depth and distance to be moved could necessitate line hauls. Supplies and ammunition will stay in the same LR which will reduce the availability of rail, particularly in LR2.

(2) Other Causes. A FEBA displacing westward causes transport assets to be urgently needed to perform many missions simultaneously. Every mission may not be accommodated. Given a choice of moving those units about to be captured or repositioning supplies, the supplies will be sacrificed. The problem with positioning supplies in the corps area prior to hostilities in

an effort to save wartime transport time and resources is that more tonnage has to move rearward, usually with fewer truck companies available for the task. Providing sufficient warning time prior to movement can reduce the tonnage to be moved.

g. **Class VII and IX Parts.** This mission generated only modest requirements for light and medium trucks for LR1-4.

(1) **Transportation Causes.** There appears to be a high possibility that backhauled trailers will be loaded with less than the standard planning factor tonnage.

(2) **Other Causes.** Determining Class VII tonnage is analogous to identifying unit move weights. Requirements for force structure will increase or decrease as future study better defines the requirements. The desire to repair vehicles or recover parts/components that would otherwise be salvaged could marginally raise transportation needs. Total ordnance capability to repair may influence the amount of work to be retrograded.

h. **Maintenance Evacuation.** This is the largest component for HET requirements.

(1) **Transportation Causes.** The road and weather conditions and distance to travel will determine the need for a line haul.

(2) **Other Causes.** FEBA movement is most influential because the first part of evacuation is initial recovery of the vehicle from the damaged site to the CP. Offensive thrusts may leave a lot of vehicles on the wrong side of the FEBA. The degree that maintenance can fix vehicles in forward locations greatly influences HET requirements. HET battle losses can be expected to be higher than for other transportation vehicles because its mission profile is predominantly in the forward areas.

k. **Unit Moves (tracked vehicles).** Ordnance units will need HET support to move unrepaired tracked vehicles to the unit's new location.

(1) **Transportation Causes.** The requirement to line haul the damaged vehicles will double the number of HET needed. Damaged vehicles may take longer to load and unload.

(2) **Other Causes.** The amount of warning time prior to the maintenance unit move could significantly influence this mission. Many of the factors and logic/methodology used to estimate the workload could be refined/improved to obtain a result that varies widely with this analysis.

l. **Tactical Relocation.** The recent (mid-CY (calendar year) 1991) acceptance of this mission as a legitimate justification for HET force structure has resulted in a tentative addition of one 96-truck company based on preliminary discussions by TRADOC action officers.

(1) **Transportation Causes.** Unknown.

(2) **Other Causes.** Use of HETs for this purpose rests entirely on operational issues. Diverse examples are the degree of offensive action desired or necessary, the ability of the enemy to threaten points along the FEBA, and the degree that good intelligence gathering accurately portrays enemy weaknesses.

7-4. CONCLUSION. In answer to EEA 4, the dislocation of the FEBA is the overwhelming influence on the need for additions to overall force structure, including US force structure additions. Other operational factors are the degree of peacetime preparation for war, warning time prior to movement, host nation support, and air superiority. Doctrinal improvements, primarily the formal recognition of retrograde missions and the impact of FEBA dislocation, would allow the force structure process, and hence the FASTALS program, to better estimate transportation force structure requirements.

CHAPTER 8

RETROGRADE PLANNING FACTOR

8-1. PURPOSE. To determine if a "rule of thumb" can be developed for the amount of force structure to transport retrograde cargo based on the data presented in Chapters 2 through 6.

8-2. INTRODUCTION

a. The two scenarios included in this study are most dissimilar when analyzing whether or not a planning factor can be derived that is useful for retrograde planning purposes. PFCAE-96 provides the basis to estimate the range of the results when rather severe withdrawal occurs. PFASS provides a baseline from which to begin measuring the effects of FEBA loss.

b. This study contains no reference to a situation when the FEBA moves forward. However, there are considerable similarities from a transportation requirements viewpoint between an army withdrawing and one that is advancing. The FASTALS Model's implementation of the current transportation force structure process may portray wide differences in force structure because it does not accommodate several of the retrograde topics that have been found to be important up to this point, unit moves and supply relocation being the most critical.

8-3. CRITERIA USED FOR MEASURING. Several references are made in earlier chapters to logic alternatives for accumulating retrograde tonnage.

a. The ETRANS unit move analysis used the MARC values for the frequency that units move on the battlefield. These appear conservative for the PFCAE-96 scenario; they may be somewhat liberal for PFASS. MARC values are generic in nature, that is, they do not reflect the characteristics of the theater to which they are being applied. How often a unit must move is in part a function of the weapons, tactics, and the sophistication of the enemy as well as efficient use of available resources, terrain, cover, and concealment.

b. The depth of each LR is important in gauging the effects of a specific amount of FEBA movement. A given westward displacement of the FEBA will result in some portion of the LR support units and supplies being moved rearward within the LR and some portion being shipped further to the rear. The distance is important when considering the need for local versus line hauls or the use of rail.

c. The amount of time that is available to plan a withdrawal can be a large consideration. Perhaps supplies can be managed so that all items on the ground will be exhausted at the precise moment that abandonment of that supply point becomes necessary. It so happens that this particular circumstance appears to be a characteristic of both scenarios. If supplies are forward-stored in LR2, an evacuation plan is needed to estimate the transport resources needed, and, more importantly, what transport unit will perform the mission.

d. The tonnage actually on the ground to move in retrograde should be compared to the tonnage being hauled forward. The "other than nonmobile weight" component of unit weight becomes an important estimating tool. Analysis of FASTALS Workload 18--used to determine medium truck requirements for forward moves--provides an interesting result; only 50 percent of Workload 18 is in LR1 and 2, but a much larger proportion of the unit and supply tonnage that needs movement during a withdrawal will be in LR1 and 2. The intricacies and subtle ramifications of how FASTALS Workload 18 generates medium truck companies are not included in this study. The question that needs to be answered may not be "what has to move in retrograde," but "what can be moved" with the assets available. Without an adequate mechanism to stimulate retrograde requirements, the "what can be moved" may be much less than "what has to be moved."

8-4. PFCAE-96 AND PFASS SIMILARITIES

a. Table 8-1 displays the results of Chapter 4. EPW and Class VII and IX requirements for both scenarios are very similar. An argument can be made that the light-medium truck companies can absorb these relatively small workloads. It appears that FEBA movement has little effect on these missions.

Table 8-1. Truck Companies for Retrograde Operations (PFASS\PFCAE-96)

Mission	LR1		LR2		LR3-5	
	Light	Medium	Light	Medium	Light	Medium
EPW	.02 .02		.02 .02		.02 .02	
NEO					4.62 3.70	
KIA	.15 .08			.18 .09		
Mail	.27 .21		.27 .21	.05 .05	.17 .14	.03 .03
Unit moves		2.74 1.67		5.27 1.63		2.23
Supply and ammunition stocks				1.66 .38		1.84
Class VII and IX parts	.02 .04			.10 .13		.01 .01
	.46 .35	2.74 1.67	.29 .23	7.26 2.28	4.82 3.87	4.11 .04

b. The retrograde calculations for the remaining missions provide a minimum differential between the two scenarios of approximately double for KIA to a maximum of nine for movement of supply and ammunition stocks. The minimum values (all except Class VII and IX Parts are PFASS) could reasonably be used as a floor requirement. Applying the foregoing rationale, Table 8-2 provides the minimum number of truck companies required to accommodate retrograde needs. Because the NEO estimate is not well-defined, the values for the two scenarios have been averaged. In addition to forward and retrograde movements, transport may be needed for other requirements, for example, moving supplies or units laterally or out of sector.

Table 8-2. Minimum Total Truck Companies for Retrograde Operations

Mission	LR1		LR2		LR3-5	
	Light	Medium	Light	Medium	Light	Medium
EPW	.02		.02		.03	
NEO					4.16	
KIA	.08			.09		
Mail	.21		.21	.05	.14	.03
Unit moves		1.67		1.63		
Supply and ammunition stocks				.38		
Class VII and IX Parts	.02			.10		.01
	.33	1.67	.23	2.25	4.33	.04

Total light truck companies = 4.89
Total medium truck companies = 3.96

8-5. PFCAE-96 AND PFASS DIFFERENCES

a. PFCAE-96 is a nightmare from a transportation viewpoint. In comparison, PFASS will not be a challenge. When the FEBA moves as fast as that in the PFCAE-96 scenario, Army units will be continually resettling their positions, packing up for the next move, or on the road trying to get behind the next defensive line. The enemy will be trying to exploit his successes. The need for transport and MHE will be extreme, and the critically of medium truck resources will be acute.

b. From that perspective, it is understandable that this study of the PFCAE-96 scenario estimated the need for an additional 10.15 medium truck companies (2.74 for LR1 + 7.26 for LR2 + 4.11 for LR3-5 = 14.11 - 3.96 minimum requirement = 10.15). This is an understatement. A review of paragraph 3-10 will underscore the fact that changing the method of calculating unit moves could have yielded a much higher result.

c. Truck companies that support a retrograde operation have the efficiency advantage of programming backhauls into their daily operations. Offensive operations have a much lower opportunity for using backhauls; therefore, a greater number of vehicles will be needed to move a given amount of tonnage forward than rearward. Figure 8-1 is a conceptualization of the relationship between the need for transportation and the type of Army operation. Movement along the curve in either direction from the nadir represents the additional lift required to support operations. An advantage of an advancing FEBA is that time is less critical. The penalty for delaying to move units or supplies during a withdrawal is their loss to the enemy, but the penalty for delaying a move during an advance is the inability of the units or supplies to provide the maximum contribution to the battle. The increased transportation requirement shown for the offense is in consideration of the lack of backhaul potential for unit moves and supplies which is available during a withdrawal, and the increasing resupply distances during an advance.

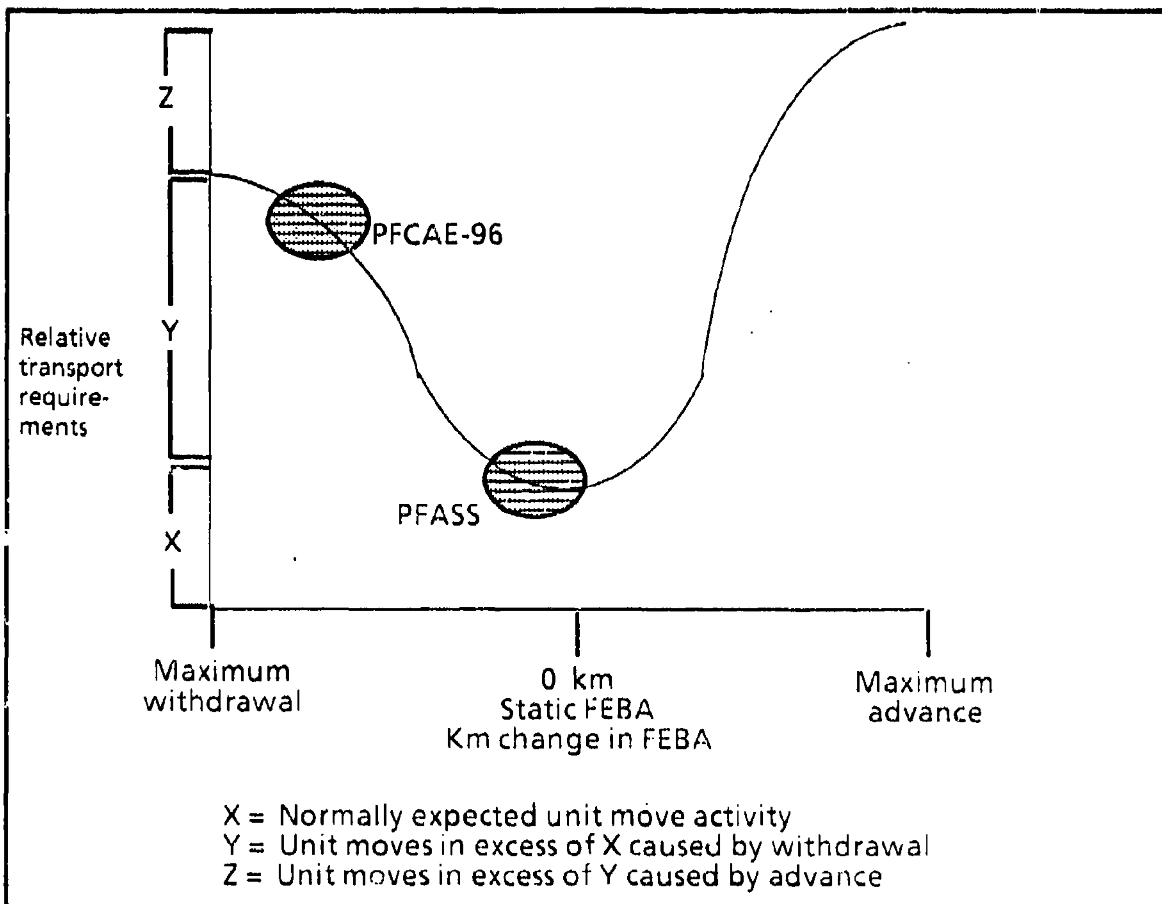

Figure 8-1. Conceptual Relationship Between Transport Needs and FEBA Movement

d. The lowest point of the curve represents the minimum amount of additional transportation resources (bracket X) needed to perform the retrograde (and lateral) missions when the FEBA is near stationary. It corresponds to the PFASS scenario. As the FEBA changes in either direction, the need for transport increases. The need could increase abruptly if the FEBA exhibits sudden change. The PFCAE-96 workload is on the curve to the left of the static point contained in bracket Y approaching the "max withdrawal" value.

e. The segment of the transportation requirements curve to the right of the minimum value in bracket B represents increased transport needs for offensive action. As more territory is captured, the resupply lines become longer. More important, all support units have to move forward periodically in order to provide adequate support to the combat units in LR1. The total transportation workload could be larger than that required for retrograde because backhauls are at a minimum, and the backhaul integration factor for the large transport workloads are nearing the minimum value of .15 (see paragraph 4-6, Chapter 4). Bracket Z represents the difference between the transport needs during a withdrawal, which accrues a higher benefit from backhauls compared to the offensive, which does not.

f. FASTALS will register an increase in Workload 18 for offensive action based on negotiation of longer supply lines. However, the currently approved process does not capture all the difference because unit moves, which are a highly significant transportation workload, are not included beyond initial unit deployments.

8-6. ESTIMATING THE RETROGRADE FORCE STRUCTURE. The problem for the general staff war planner is to understand where on Figure 8-1 the transportation plan should fall. A correct determination would be fortuitous but not expected, as no one can divine the outcome of a particular battle or campaign with assurance. However, computer simulation can provide an estimate similar to the analysis of the two scenarios in ETRANS, and the results can be used as a planning tool.

a. The minimum estimated force structure needed to support retrograde operations in the Central Region is shown at Table 8-2. Table 8-3 is the force structure difference between Table 8-1 and Table 8-2. It represents the transportation force structure additions needed to support a scenario exhibiting a FEBA continuing to move adversely at a relatively high rate.

Table 8-3. Additional Retrograde Force Structure

Mission	LR1		LR2		LR3-5	
	Light	Medium	Light	Medium	Light	Medium
KIA	.07			.09		
Mail	.06		.06		.03	
Unit		1.07		3.64		2.23
Supply and ammunition stocks				1.28		1.84
Class VII and IX parts	.02			.03		
	.15	1.07	.06	5.04	.03	4.07

Total light truck companies = .24
Total medium truck companies = 10.18

b. The quantities of light trucks shown are very small. Except for mail, the light truck requirements for LR1 and 2 can reasonably be directed toward the light-medium truck companies that are provided to the corps for support of the divisions. Mail differences should be absorbed by a truck company specifically formed to support the European postal system. Additional light truck companies are not further evaluated.

c. The differences in additional medium truck companies are the result of adverse FEBA movement. The degree and maximum range of FEBA movement to be experienced and still be considered transportation neutral is unknown. Movement of 50 km or less in either direction of the initial FEBA seems reasonable without unduly influencing the retrograde analysis done for PFASS. In comparison, the PFCAE-96 loss of 644.1 km may reasonably be regarded as a near maximum loss during a 90-day campaign. A schematic of the result is provided in Figure 8-2.

8-7. RETROGRADE TRANSPORTATION "RULE OF THUMB"

a. **General.** Each scenario has different characteristics, force mixes, and results. Any rule developed for transportation force increases should be in terms that are widely applicable. A measurement in terms of division equivalents, battle losses, or current transportation force structure, among other possible terms, is not applicable to retrograde requirements. The two prime generators of retrograde requirements are unit moves and rearward displacement of supply stocks (forward displacement of supply stocks would be captured in Workload 18). Both are directly related to the population that needs support in the theater.

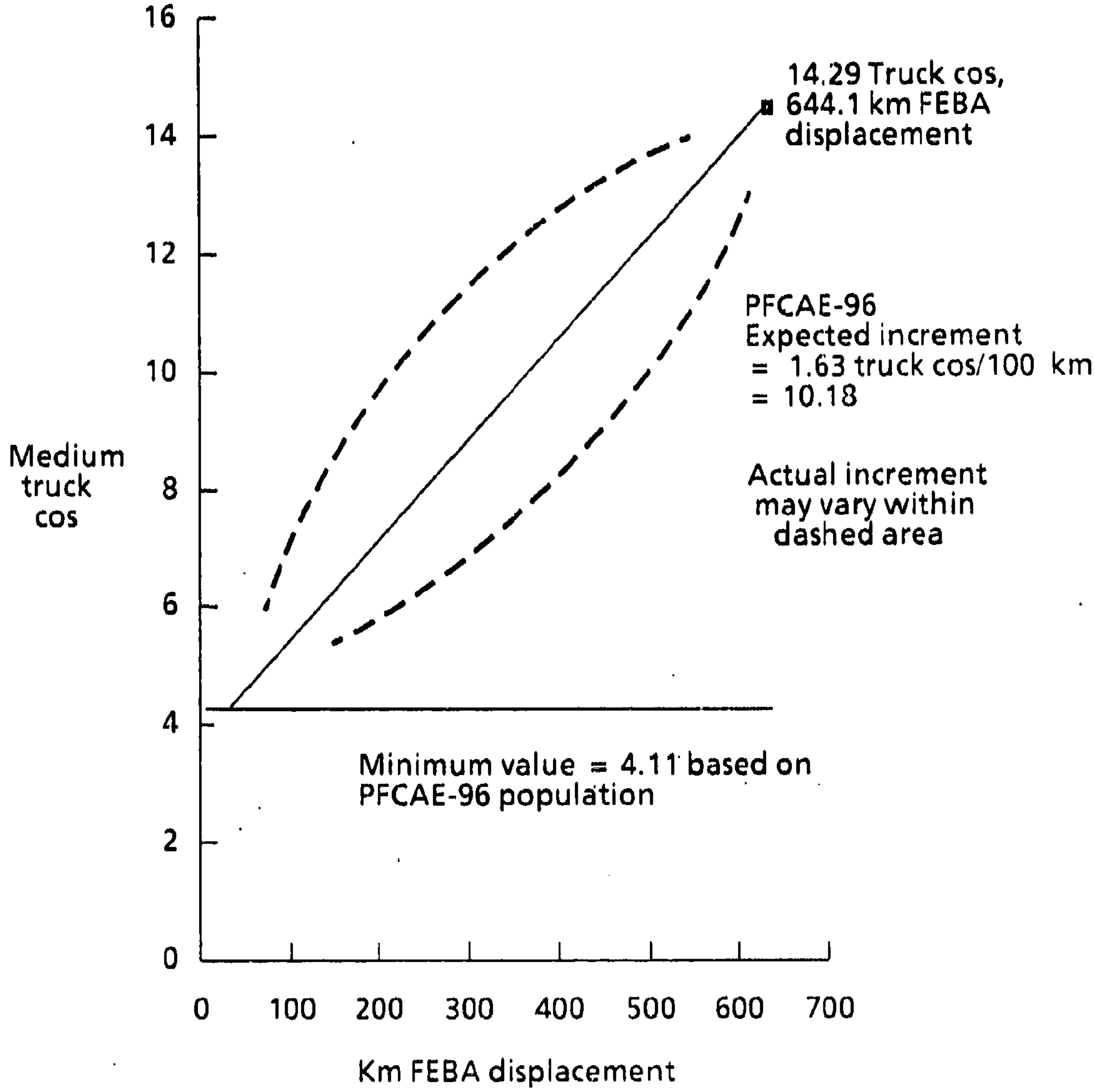

Figure 8-2. Medium Truck Requirements for Retrograde (PFCAE-96)

b. **Medium Truck Company.** The needs of the US Army population in LR1 and 2 are primarily responsible for generating the truck companies that make up the minimum requirement. The LR1 and 2 population will continue to contribute most, but not all, of the need for increases experienced by PFCAE-96, but LR3-5 will also contribute. The totals for FASTALS Workload 1, US Army Population in Thousands, for LR1-5 is shown in Table 8-4.

Table 8-4. US Army Population (000) (PFASS\PFCAE-96)

Time period								
3	4	5	6	7	8	9	10	11
419.7 329.7	483.5 376.7	493.8 387.0	574.8 467.0	543.4 539.8	497.0 545.2	478.2 548.9	482.2 556.8	483.3 558.2

Average for PFCAE-96 = 495.1
Average for PFASS = 478.8

(1) Using units of 100 thousand US Army population as a unit of measure for transportation requirements, the PFASS average population of 478.8 thousand required .83 medium truck companies per 100 thousand US Army population (3.96 medium truck companies/478.8 thousand = .83). This figure should be extended to be interpreted as the minimum requirement for all Central European scenarios for this population. The PFCAE-96 population is slightly higher, and the minimum medium truck company value is 4.11 (495.1 ÷ 100 x .83 = 4.11). The .83 per 100,000 theater population will be referred to as the "Population Factor."

(2) The difference in medium truck companies between PFCAE-96 and PFASS is 10.18. The difference in FEBA displacement is approximately 625.2 km (PFCAE-96 = 644.1; PFASS 18.9). The marginal additional number of medium truck companies for PFCAE-96 required for each 100 km FEBA displacement is 1.63 (10.18 truck cos/625.2km = .0163 X 100 = 1.63). Figure 8-2 is a representation of these calculations. The exact requirement may not be linear in nature but could be expected to fall within a range of values represented by the dotted lines. Using the average total population for PFCAE-96 of 495,100, a factor of .33 medium truck companies per 100,000 theater population for every 100 km lost or gained can be calculated (1.63 ÷ 4.59 = .33). At several junctures, ETRANS has chosen a conservative method of calculating force structure, so this estimate of .33 should be taken as an absolute minimum figure. The .33 will be referred to as the "FEBA Displacement Factor."

(3) Both PFCAE-96 and PFASS were 90-day scenarios. Since wars do not necessarily last 90 days, the element of time should be addressed.

(a) The FEBA displacement factor of .33/100K population/100 km was derived based on the total FEBA displacement occurring over a 90-day period. However, the desired planning factor needs to account for both the quantity-distance (population-km) involved and the specific period (days) over which the FEBA movement occurred. For example, if the PFCAE-96 FEBA moved 644 km in only 45 days (instead of 90), it is reasonable to assume that twice as many trucks would be needed for moving the units, supplies, etc. Similarly, if the time were doubled, only half the number of truck companies would be needed. This is equivalent to saying that the truck company requirement is inversely proportional to the time required for a given movement, or it is directly proportional to the average rate (km/day) of the cargo movement. Incorporating the 90-day period of PFCAE-96 into the initially derived factor (.33) gives a 100-km FEBA movement-related requirement factor of .297 cos/100K population (km/day). Expressing this revised FEBA Displacement Factor as an equation yields:

$$Med\ trk\ cos = .297\ x\ (population\ in\ 100K)\ x\ (avg\ FEBA\ movement\ rate\ in\ km/day)$$

(b) Given the assumptions above, population, FEBA movement, and time can be adjusted whereby the following conditions all result in the same answer:

Population	100K;	FEBA movement	100 km;	time 90 days	= .33 medium truck cos
"	200K	"	100 km;	time 180 days	= .33 medium truck cos
"	50K	"	100 km;	time 45 days	= .33 medium truck cos
"	50K	"	200 km;	time 90 days	= .33 medium truck cos

(c) A sample calculation is provided below:

$$Population\ 300k;\ FEBA\ movement\ 250km;\ time\ 75\ days = 2.97\ medium\ truck\ cos$$
$$(.297\ x\ 3\ x\ 250\ /\ 75\ days = 2.97\ med\ trk\ cos)$$

(4) Several caution must be highlighted.

(a) The answers appear reasonable only for distances and time periods that allow for an orderly military operation. Large FEBA movements over short time periods may produce exaggerated answers.

(b) The FASTALS program will identify the portion of the answer attributable to resupply requirements when the FEBA moves forward. Unit move requirements, approximately 70 percent of the figure for FEBA displacement, would not be captured by FASTALS.

(c) The relationship of time, distance, and workload may, or may not, be synergistic in practice.

(d) Note that the medium truck company requirements for retrograde cargo based on the Population Factor are not varied based on time considerations.

(5) An example of estimating requirements for medium truck companies can be provided using the following parameters:

- Theater population = 400,00 for D-day to D+44
- Theater population = 600,00 for D+45 to D+119
- Expected FEBA loss from D-day to D+29 is 200 km
- Expected FEBA gain from D+30 to D+59 is 0 km
- Expected FEBA gain from D+60 to D+119 is 400 km

The calculations for the Population Factor yield 3.32 medium truck companies for the first 45 days and 4.98 companies thereafter (.83 factor x 4.0 population; and .83 x 6.0). The FEBA Displacement Factor requirement for the 200-km withdrawal is 7.92 medium truck companies (.297 x 4 x 200 km/30). There is no requirement for medium truck companies during D+30 to D+59 due to FEBA displacement. For days D+60 to D+119, 11.88 medium truck companies are needed for the offensive FEBA movement, of which approximately 30 percent will be included in the FASTALS calculations for medium truck force structure. The example is shown graphically in Figure 8-3.

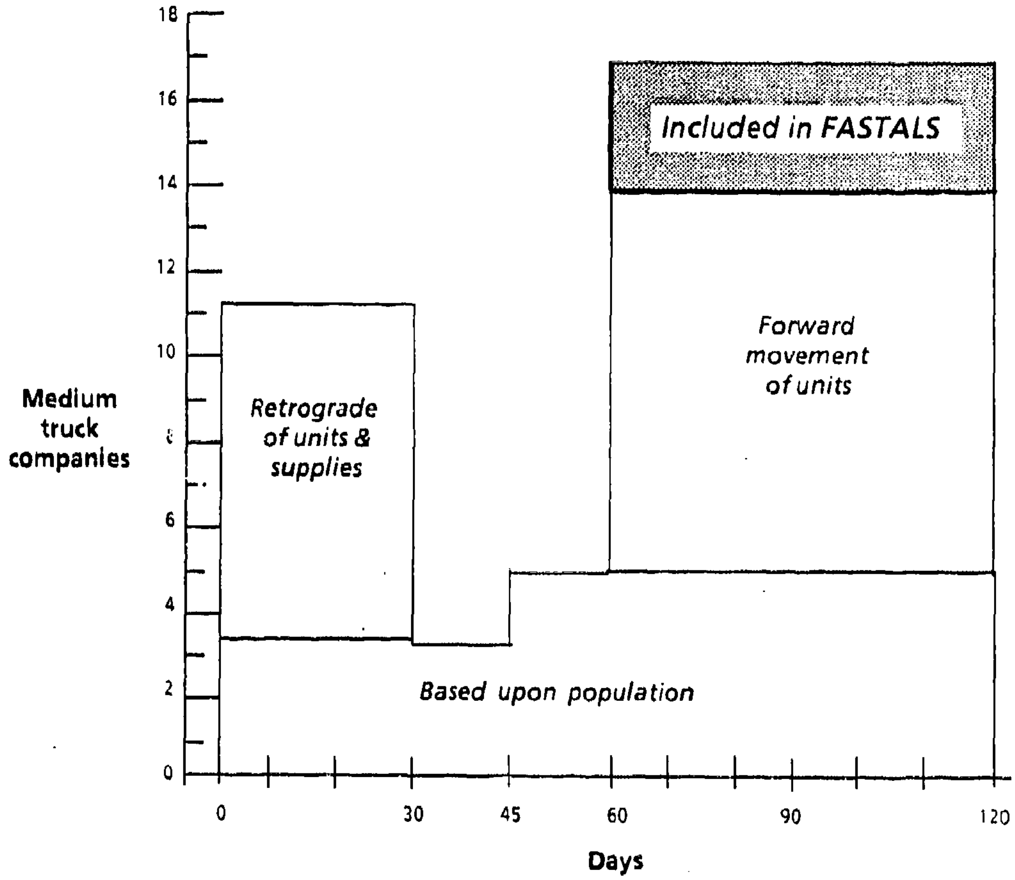

Figure 8-3. Sample Representation of Medium Truck Force Structure Required

c. **Light Truck Company.** A similar planning factor figure for light trucks can be useful for estimating the NEO requirement. Paragraph 3-6, Chapter 3, estimates light truck requirements to be 4.62 for PFCAE-96 and 3.70 for PFASS. When divided into the minimum NEO population for each, both scenarios need .92 light truck companies per 100,000 NEO population. However, to emphasize the point made in earlier chapters, host nation buses are the preferred method to transport NEO participants. USAREUR or other responsible activity should program this requirement in advance. No tactical light truck company is needed.

8-6. CONCLUSION. The current transportation force structure requirements process, as implemented in FASTALS, can be modified to account for retrograde activities. Adjustments for the Central Region should include an additional 4.11 medium truck companies based on the PFCAE-96 Population Factor of .83 medium truck companies per 100,000 US Army population. The PFCAE-96 FEBA movement should add another 10.18 medium truck companies based on a FEBA

Displacement Factor of .297 per 100,000 population per 100 km FEBA movement for a 90-day time period. Additionally, light truck companies should be added at a rate of .92 for every 100,000 NEO participants.

APPENDIX A

STUDY CONTRIBUTORS

1. STUDY TEAM

a. Study Director

MAJ Joseph P. Brown, Force Systems Directorate

b. Team Members

CPT Arnethia Murdock
Ms. Kumud Mathur

c. Other Contributors

MAJ Barry V. Brassard
MAJ Jeanette M. Harris
MAJ Joseph Spafford
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Ms. Elizabeth Pyle

2. PRODUCT REVIEW BOARD

Mr. Ronald J. Iekel, Chairman
Mr. Walter Aldridge
Ms. Rose Brown

3. EXTERNAL CONTRIBUTORS

Mr. Tim Fulton, US Army Transportation School
Mr. Gerald Neilson, US Army Materiel Systems Analysis Agency

APPENDIX B

STUDY DIRECTIVE

DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF FOR LOGISTICS
WASHINGTON, DC 20310-0500

DALO-PLA

21 SEP 1990

MEMORANDUM FOR Director, U.S. Army Concepts Analysis Agency,
8120 Woodmont Avenue, Bethesda, MD 20814-2797

SUBJECT: Study Directive for the European Transportation Requirements for the Backhaul of Personnel/Cargo (ETRANS) Study

1. PURPOSE OF STUDY DIRECTIVE. This directive provides tasking, direction, and guidance for the ETRANS Study. The study is to quantitatively determine whether assets planned for wartime transportation of personnel/cargo forward to the combat zone are sufficient to also satisfy the anticipated retrograde requirements. Retrograde requirements are the return of personnel/cargo from division areas through corps areas to the rear combat and communication zones in Central Europe.

2. BACKGROUND. The prevalent response to questions regarding retrograde movements away from the battle area has been that there would be sufficient empty transportation resources returning from the forward areas to accommodate all such rearward movement requirements. Two recent U.S. Army Concepts Analysis Agency (CAA) studies examined this question in some detail. The first, Wartime Retrograde of Damaged Materiel from a Theater of Operations (RETRO), conducted a literature search for Army doctrine and discussed some considerations for modeling rearward movements. The second study, Retrograde Transportation (RETRO II) provided theoretical logic for the calculation of personnel, general cargo, and end items needing transport away from the forward combat zone during the course of a conflict in the European Central Region. This logic was designed to be compatible with that of the Army's support force structuring model, Force Analysis Simulation of Theater Administrative and Logistic Support (FASTALS). This study builds on the RETRO studies and will provide a quantitative analysis.

3. STUDY SPONSOR AND STUDY DIRECTOR. HQDA, Office of the Deputy Chief of Staff for Logistics (ODCSLOG), is the study proponent. The Chief, Logistics Studies and Analyses Division (DALO-PLA), Mr. Donald Feeney, is the proponent's study sponsor and coordinating point of contact.

4. STUDY AGENCY. U.S. Army Concepts Analysis Agency (CAA), Bethesda, MD 20814-2797.

5. TERMS OF REFERENCE.

a. Scope. Analysis of U.S. support force structure in the NATO Central Region up to the first 90 days of war. Data from the Program Force Capability Assessment Europe 96 (PFCAE 96) Study will be used as the analytical base case. Results from an updated Central Region (e.g., Conventional Forces Europe (CFE) analysis) combat simulation will be used if FASTALS data becomes available by 31 August 1990.

DALO-PLA
SUBJECT: Study Directive for the European Transportation Requirements for the Backhaul of Personnel/Cargo (ETRANS) Study

b. Objectives.

(1) To determine the effect of retrograde transportation requirements on the total force structure.

(2) To determine if a "retrograde transportation force structure planning factor" can be developed.

c. Timeframe. Input data from the CAA PFCAE 96 will be used for both base case and sensitivity analyses. If scope is broadened based on available updated data, the timeframe will be adjusted accordingly.

d. Assumptions.

(1) Data from the Army Force Planning Data and Assumptions (or a single updated threat) are appropriate for this analysis.

(2) Host nation support will be available as bilaterally agreed.

(3) The use of transportation modes consistent with U.S. Army Europe (USAREUR) theater policy is appropriate for this analysis.

e. Study Limitations. All data for analysis will come from, or be derived from, existing sources. Potential exists for unavailability of formally approved data prior to completion of the study. Sensitivity analysis will be conducted to examine the effects of known data uncertainty.

f. Essential Elements of Analysis (EEA).

(1) What is the total U.S. retrograde transportation requirement (number of personnel, tons, etc.) for the NATO Central Region?

(2) What portion of the heavy truck companies currently in the force structure exists as a result of requirements to evacuate damaged vehicles?

(3) What additions, if any, to U.S. wartime transportation force structure are necessary to execute retrograde requirements?

(4) If additions to transportation force structure are needed to support retrograde missions, what are the factors that affect the quantification of these additions?

(5) If the study results can be extended to support it, what is the value, or range of values, for a "retrograde transportation force structure planning factor."

DALO-PLA
SUBJECT: Study Directive for the European Transportation Requirements for the Backhaul of Personnel/Cargo (ETRANS) Study

6. RESPONSIBILITIES.

a. The study proponent, ODCSLOG (DALO-PLA), will:

(1) Provide a study coordinator.

(2) Schedule In-process Reviews (IPRs) as required.

(3) Assure that authoritative support, coordination and required logistic data are available from DA staff elements and major command elements to include U.S. Army Europe, Training and Doctrine Command, and the Army Materiel Command.

b. The study agency, CAA, will:

(1) Designate a study director and provide a study team.

(2) Communicate directly with ODCSLOG and other agencies as required in conducting the study.

(3) Conduct IPRs as requested by the study proponent.

(4) Provide final study documentation.

7. LITERATURE SEARCH.

a. A detailed literature search was conducted as part of the RETRO Study. Current queries to the Defense Logistics Studies Information Exchange and the Defense Technical Information Center were requested but no further references were found that supported or duplicated this directive.

b. Emphasis should be on USAREUR application of U.S. logistic doctrine to the Central European area of operations. Specific consideration should therefore be given to the following documents that were not referenced in previous RETRO Studies:

(1) TRADOC Study, ACN 82624, Equipment Transporter Requirements Study (U).

(2) Institute for Defense Analysis Paper P-2197, An Analysis of RSI Potential for Reception and Onward Movement of U.S. Forces in Europe (U).

DALO-PLA
SUBJECT: Study Directive for the European Transportation Requirements for the Backhaul of Personnel/Cargo (ETRANS) Study

8. REFERENCES. The following references apply:

a. AR 5-5, Army Studies and Analysis, 15 Oct 81.

b. AR 10-38, U.S. Army Concepts Analysis Agency, 18 Dec 85.

c. Army Force Planning Data and Assumptions, Aug 87.

d. USAREUR OPLAN 4102

e. 55L Series TOE

9. ADMINISTRATION.

a. Funds required for TDY, per diem, etc., are the responsibility of each participating agency.

b. ADP requirements other than copies of data files needed from other activities will be provided by CAA.

c. Control Procedures.

(1) The study proponent will arrange for IPRs as required.

(2) Milestones.

(a) CAA draft study report to proponent by 1 Mar 91.

(b) Proponent's draft report review to CAA by 1 Apr 91.

d. CAA will prepare and update the Research and Technology Work Summary (DD Form 1498) through study completion.

e. The study proponent will prepare a written evaluation of the study results IAW AR 5-5 following study completion.

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SUBJECT: Study Directive for the European Transportation Requirements for the Backhaul of Personnel/Cargo (ETRANS) Study

f. This study directive complies with the mission, functions, and procedures of CAA and has been coordinated in accordance with paragraph 6, AR 10-38.

FOR THE DEPUTY CHIEF OF STAFF FOR LOGISTICS:

COL, GS
for JERE H. AKIN
Major General. GS
Director of Plans and Operations

APPENDIX C

BIBLIOGRAPHY*

DEPARTMENT OF THE ARMY

Department of the Army (DA) Publications

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OTHER PUBLICATIONS

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APPENDIX D

SCENARIO LOGISTICS REPORTS

D-1. PURPOSE. To provide data used in the ETRANS Study contained in the Logistics Report generated by CEM for PFCAE-96 and PFASS.

D-2. BACKGROUND. The CEM Logistics Report aggregates data in 4-day time periods. The first time period contains data from D-day to D-day+3, the first 4 days of battle. The Logistics Report also contains data for other allied as well as for opposing forces which have been deleted from the data in this appendix.

a. PFCAE-96 Logistics Report for supply and maintenance data for US tracked vehicles.

Day	Type vehicle	Sequence number	Issued from theater reserve	Combat losses		Noncombat losses	
				Temp	Perm	Temp	Perm
4	APC	1	105	509	96	60	4
8	APC	1	105	417	40	60	3
12	APC	1	105	700	129	79	6
16	APC	1	105	667	104	69	5
20	APC	1	105	719	180	65	7
24	APC	1	105	731	141	68	5
28	APC	1	105	724	135	83	6
32	APC	1	105	784	208	74	6
36	APC	1	105	778	201	62	7
40	APC	1	105	778	167	55	7
44	APC	1	105	666	168	57	7
48	APC	1	105	628	130	62	6
52	APC	1	105	560	123	60	7
56	APC	1	0	493	103	53	6
60	APC	1	0	378	98	43	6
64	APC	1	0	268	79	37	6
68	APC	1	0	214	67	33	6
72	APC	1	0	209	50	29	4
76	APC	1	0	200	37	27	4
80	APC	1	0	153	35	24	4
84	APC	1	0	103	27	22	3
88	APC	1	0	124	23	21	3
92	APC	1	0	166	13	21	1
4	APC	2	10	182	39	21	3
8	APC	2	10	135	18	21	2
12	APC	2	10	197	36	28	4
16	APC	2	10	221	35	24	3
20	APC	2	10	205	44	21	4
24	APC	2	10	251	48	22	3
28	APC	2	10	278	47	26	4
32	APC	2	10	261	68	24	4

Day	Type vehicle	Sequence number	Issued from theater reserve	Combat losses Temp	Combat losses Perm	Noncombat losses Temp	Noncombat losses Perm
36	APC	2	10	235	55	21	4
40	APC	2	10	235	47	19	4
44	APC	2	10	206	43	21	4
48	APC	2	10	190	35	23	4
52	APC	2	10	203	37	21	4
56	APC	2	0	216	37	27	5
60	APC	2	0	151	38	23	5
64	APC	2	0	123	29	21	4
68	APC	2	0	109	25	18	4
72	APC	2	0	111	17	16	3
76	APC	2	0	109	13	14	3
80	APC	2	0	81	13	13	3
84	APC	2	0	70	11	11	2
88	APC	2	0	63	9	11	2
92	APC	2	0	69	7	11	1
4	APC	3	16	181	78	28	2
8	APC	3	16	110	44	47	3
12	APC	3	16	232	109	56	4
16	APC	3	16	248	121	66	5
20	APC	3	16	377	214	56	5
24	APC	3	16	311	159	47	4
28	APC	3	16	344	148	52	4
32	APC	3	16	436	232	46	4
36	APC	3	16	391	221	32	3
40	APC	3	16	301	170	26	3
44	APC	3	16	320	168	29	3
48	APC	3	16	265	144	31	4
52	APC	3	16	278	151	35	4
56	APC	3	0	262	139	28	3
60	APC	3	0	217	123	20	3
64	APC	3	0	188	89	21	3
68	APC	3	0	140	75	15	2
72	APC	3	0	98	56	13	2
76	APC	3	0	57	29	15	1
80	APC	3	0	39	20	15	1
84	APC	3	0	31	16	15	1
88	APC	3	0	22	11	15	1
92	APC	3	0	16	7	16	1
4	APC	5	0	36	6	14	1
8	APC	5	0	14	2	15	1
12	APC	5	0	39	9	20	1
16	APC	5	0	32	7	18	1
20	APC	5	0	36	13	17	2
24	APC	5	0	38	13	19	2
28	APC	5	0	46	12	24	2
32	APC	5	0	82	28	23	2
36	APC	5	0	81	29	20	2
40	APC	5	0	68	24	18	2
44	APC	5	0	70	24	19	2

Day	Type vehicle	Sequence number	Issued from theater reserve	Combat losses Temp	Combat losses Perm	Noncombat losses Temp	Noncombat losses Perm
48	APC	5	0	61	20	20	2
52	APC	5	0	58	22	22	3
56	APC	5	0	63	20	20	3
60	APC	5	0	63	22	17	3
64	APC	5	0	51	17	18	2
68	APC	5	0	46	16	16	2
72	APC	5	0	37	13	15	2
76	APC	5	0	24	8	15	2
80	APC	5	0	21	7	15	2
84	APC	5	0	16	6	14	1
88	APC	5	0	13	4	14	1
92	APC	5	0	8	2	14	1
4	APC	6	0	87	19	13	1
8	APC	6	0	41	8	14	2
12	APC	6	0	94	21	19	2
16	APC	6	0	89	19	19	3
20	APC	6	0	176	46	15	2
24	APC	6	0	165	36	13	2
28	APC	6	0	164	30	14	2
32	APC	6	0	165	40	13	2
36	APC	6	0	152	40	10	2
40	APC	6	0	134	35	9	2
44	APC	6	0	142	36	10	2
48	APC	6	0	134	32	11	2
52	APC	6	0	151	36	11	2
56	APC	6	0	112	27	9	2
60	APC	6	0	97	28	8	2
64	APC	6	0	99	24	8	2
68	APC	6	0	71	21	6	1
72	APC	6	0	55	16	5	1
76	APC	6	0	43	10	5	1
80	APC	6	0	35	7	4	1
84	APC	6	0	28	6	4	1
88	APC	6	0	24	4	4	1
92	APC	6	0	20	3	4	1
4	APC	7	138	298	40	60	7
8	APC	7	138	246	20	68	8
12	APC	7	138	353	43	90	12
16	APC	7	138	461	44	89	12
20	APC	7	138	620	83	85	14
24	APC	7	138	807	100	100	15
28	APC	7	138	1020	110	133	18
32	APC	7	138	1351	225	150	24
36	APC	7	138	1494	263	154	29
40	APC	7	138	1443	225	156	31
44	APC	7	138	1322	211	185	36
48	APC	7	138	1449	214	207	40
52	APC	7	138	1679	243	227	44
56	APC	7	0	1503	229	218	44

Day	Type vehicle	Sequence number	Issued from theater reserve	Combat losses Temp	Combat losses Perm	Noncombat losses Temp	Noncombat losses Perm
60	APC	7	0	1271	246	192	43
64	APC	7	0	1147	178	197	40
68	APC	7	0	918	177	173	38
72	APC	7	0	873	134	155	31
76	APC	7	0	839	90	146	26
80	APC	7	0	721	77	131	23
84	APC	7	0	691	74	114	20
88	APC	7	0	637	55	105	17
92	APC	7	0	558	42	100	14
4	ARTY	1	0	0	27	0	0
8	ARTY	1	0	0	23	0	0
12	ARTY	1	0	0	21	0	0
16	ARTY	1	0	0	17	0	0
20	ARTY	1	0	0	28	0	0
24	ARTY	1	0	0	23	0	0
28	ARTY	1	0	0	26	0	0
32	ARTY	1	0	0	29	0	0
36	ARTY	1	0	0	27	0	0
40	ARTY	1	0	0	40	0	0
44	ARTY	1	0	0	37	0	0
48	ARTY	1	0	0	37	0	0
52	ARTY	1	0	0	26	0	0
56	ARTY	1	0	0	19	0	0
60	ARTY	1	0	0	15	0	0
64	ARTY	1	0	0	12	0	0
68	ARTY	1	0	0	9	0	0
72	ARTY	1	0	0	6	0	0
76	ARTY	1	0	0	5	0	0
80	ARTY	1	0	0	3	0	0
84	ARTY	1	0	0	3	0	0
88	ARTY	1	0	0	2	0	0
92	ARTY	1	0	0	2	0	0
4	ARTY	2	0	0	35	0	0
8	ARTY	2	0	0	31	0	0
12	ARTY	2	0	0	32	0	0
16	ARTY	2	0	0	32	0	0
20	ARTY	2	0	0	41	0	0
24	ARTY	2	0	0	30	0	0
28	ARTY	2	0	0	46	0	0
32	ARTY	2	0	0	51	0	0
36	ARTY	2	0	0	55	0	0
40	ARTY	2	0	0	83	0	0
44	ARTY	2	0	0	83	0	0
48	ARTY	2	0	0	50	0	0
52	ARTY	2	0	0	68	0	0
56	ARTY	2	0	0	52	0	0
60	ARTY	2	0	0	44	0	0
64	ARTY	2	0	0	38	0	0
68	ARTY	2	0	0	29	0	0

Day	Type vehicle	Sequence number	Issued from theater reserve	Combat losses Temp	Combat losses Perm	Noncombat losses Temp	Noncombat losses Perm
72	ARTY	2	0	0	19	0	0
76	ARTY	2	0	0	14	0	0
80	ARTY	2	0	0	10	0	0
84	ARTY	2	0	0	8	0	0
88	ARTY	2	0	0	5	0	0
92	ARTY	2	0	0	6	0	0
4	ARTY	3	22	0	87	0	0
8	ARTY	3	22	0	108	0	0
12	ARTY	3	22	0	109	0	0
16	ARTY	3	22	0	68	0	0
20	ARTY	3	22	0	111	0	0
24	ARTY	3	22	0	87	0	0
28	ARTY	3	22	0	131	0	0
32	ARTY	3	22	0	149	0	0
36	ARTY	3	22	0	164	0	0
40	ARTY	3	22	0	228	0	0
44	ARTY	3	22	0	233	0	0
48	ARTY	3	22	0	247	0	0
52	ARTY	3	22	0	172	0	0
56	ARTY	3	0	0	138	0	0
60	ARTY	3	0	0	124	0	0
64	ARTY	3	0	0	123	0	0
68	ARTY	3	0	0	91	0	0
72	ARTY	3	0	0	59	0	0
76	ARTY	3	0	0	45	0	0
80	ARTY	3	0	0	26	0	0
84	ARTY	3	0	0	22	0	0
88	ARTY	3	0	0	14	0	0
92	ARTY	3	0	0	12	0	0
4	ARTY	4	0	0	0	0	0
8	ARTY	4	0	0	1	0	0
12	ARTY	4	0	0	0	0	0
16	ARTY	4	0	0	0	0	0
20	ARTY	4	0	0	2	0	0
24	ARTY	4	0	0	1	0	0
28	ARTY	4	0	0	1	0	0
32	ARTY	4	0	0	2	0	0
36	ARTY	4	0	0	1	0	0
40	ARTY	4	0	0	2	0	0
44	ARTY	4	0	0	2	0	0
48	ARTY	4	0	0	6	0	0
52	ARTY	4	0	0	2	0	0
56	ARTY	4	0	0	2	0	0
60	ARTY	4	0	0	3	0	0
64	ARTY	4	0	0	2	0	0
68	ARTY	4	0	0	2	0	0
72	ARTY	4	0	0	1	0	0
76	ARTY	4	0	0	1	0	0
80	ARTY	4	0	0	1	0	0

Day	Type vehicle	Sequence number	Issued from theater reserve	Combat losses Temp	Combat losses Perm	Noncombat losses Temp	Noncombat losses Perm
84	ARTY	4	0	0	1	0	0
88	ARTY	4	0	0	1	0	0
92	ARTY	4	0	0	1	0	0
4	TANK	1	55	449	106	134	8
8	TANK	1	55	161	37	137	8
12	TANK	1	55	371	115	183	13
16	TANK	1	55	345	116	176	14
20	TANK	1	55	527	227	160	16
24	TANK	1	55	451	189	145	13
28	TANK	1	55	563	170	164	14
32	TANK	1	55	572	216	149	13
36	TANK	1	55	594	230	131	15
40	TANK	1	55	407	176	124	17
44	TANK	1	55	442	177	120	15
48	TANK	1	55	328	116	118	13
52	TANK	1	55	328	105	111	11
56	TANK	1	0	278	92	101	12
60	TANK	1	0	259	99	87	12
64	TANK	1	0	203	89	75	11
68	TANK	1	0	176	75	65	10
72	TANK	1	0	120	48	62	8
76	TANK	1	0	90	33	66	8
80	TANK	1	0	96	39	61	9
84	TANK	1	0	75	27	57	7
88	TANK	1	0	50	18	57	6
92	TANK	1	0	16	4	62	4
4	TANK	2	0	5	1	1	0
8	TANK	2	0	5	1	15	1
12	TANK	2	0	16	6	14	1
16	TANK	2	0	23	8	13	1
20	TANK	2	0	70	35	7	1
24	TANK	2	0	50	15	20	1
28	TANK	2	0	146	49	40	2
32	TANK	2	0	344	157	41	4
36	TANK	2	0	217	108	33	4
40	TANK	2	0	212	102	34	4
44	TANK	2	0	259	108	55	6
48	TANK	2	0	221	105	64	8
52	TANK	2	0	263	130	84	10
56	TANK	2	0	276	127	77	11
60	TANK	2	0	216	103	66	10
64	TANK	2	0	196	74	77	9
68	TANK	2	0	163	75	65	10
72	TANK	2	0	121	54	59	8
76	TANK	2	0	86	33	57	6
80	TANK	2	0	60	20	55	5
84	TANK	2	0	53	18	52	5
88	TANK	2	0	42	12	50	4
92	TANK	2	0	35	10	50	4

Day	Type vehicle	Sequence number	Issued from theater reserve	Combat losses Temp	Combat losses Perm	Noncombat losses Temp	Noncombat losses Perm
4	TANK	3	0	4	6	1	0
8	TANK	3	0	3	5	3	0
12	TANK	3	0	8	14	4	0
16	TANK	3	0	17	28	10	1
20	TANK	3	0	721	118	22	2
24	TANK	3	0	104	170	44	4
28	TANK	3	0	142	211	63	5
32	TANK	3	0	273	478	78	7
36	TANK	3	0	249	407	59	7
40	TANK	3	0	142	228	44	6
44	TANK	3	0	177	250	49	6
48	TANK	3	0	162	219	48	6
52	TANK	3	0	120	170	41	5
56	TANK	3	0	93	133	34	5
60	TANK	3	0	67	90	27	4
64	TANK	3	0	47	58	23	3
68	TANK	3	0	39	55	16	3
72	TANK	3	0	21	29	14	2
76	TANK	3	0	18	23	13	2
80	TANK	3	0	10	12	12	1
84	TANK	3	0	7	9	11	1
88	TANK	3	0	6	6	11	1
92	TANK	3	0	5	5	11	1
4	TANK	7	0	44	15	7	0
8	TANK	7	0	52	7	5	0
12	TANK	7	0	69	11	7	1
16	TANK	7	0	68	9	6	0
20	TANK	7	0	69	12	5	1
24	TANK	7	0	74	12	5	0
28	TANK	7	0	94	12	7	1
32	TANK	7	0	87	21	7	1
36	TANK	7	0	91	23	7	1
40	TANK	7	0	94	16	6	1
44	TANK	7	0	112	21	7	1
48	TANK	7	0	127	20	7	1
52	TANK	7	0	123	18	8	1
56	TANK	7	0	99	18	8	1
60	TANK	7	0	74	17	6	1
64	TANK	7	0	68	12	6	1
68	TANK	7	0	50	11	5	1
72	TANK	7	0	47	7	4	1
76	TANK	7	0	67	6	4	1
80	TANK	7	0	49	4	4	1
84	TANK	7	0	38	4	3	0
88	TANK	7	0	39	3	3	0
92	TANK	7	0	44	2	3	0
4	TANK	8	0	1	3	13	1
8	TANK	8	0	1	2	14	1

Day	Type vehicle	Sequence number	Issued from theater reserve	Combat losses		Noncombat losses	
				Temp	Perm	Temp	Perm
12	TANK	8	0	1	2	19	1
16	TANK	8	0	0	1	19	1
20	TANK	8	0	1	1	18	2
24	TANK	8	0	0	1	19	2
28	TANK	8	0	0	1	25	2
32	TANK	8	0	1	2	27	3
36	TANK	8	0	1	2	28	4
40	TANK	8	0	1	1	27	4
44	TANK	8	0	1	2	31	5
48	TANK	8	0	2	2	36	5
52	TANK	8	0	1	2	38	5
56	TANK	8	0	1	2	39	6
60	TANK	8	0	1	2	38	6
64	TANK	8	0	1	2	37	6
68	TANK	8	0	1	2	36	7
72	TANK	8	0	1	1	35	5
76	TANK	8	0	1	1	36	5
80	TANK	8	0	1	1	36	4
84	TANK	8	0	1	1	34	4
88	TANK	8	0	0	1	33	3
92	TANK	8	0	0	0	33	3

b. PFASS Logistics Report for supply and maintenance data for US tracked vehicles.

Day	Type vehicle	Sequence number	Issued from theater reserve	Combat losses		Noncombat losses	
				Temp	Perm	Temp	Perm
4	APC	1	105	35	7	23	1
8	APC	1	105	256	65	89	6
12	APC	1	105	270	68	92	6
16	APC	1	105	376	90	98	7
20	APC	1	105	439	115	91	6
24	APC	1	105	357	88	95	7
28	APC	1	105	352	78	100	7
32	APC	1	105	349	78	101	7
36	APC	1	105	323	68	104	7
40	APC	1	105	327	58	115	7
44	APC	1	105	358	57	133	8
48	APC	1	105	318	45	141	9
52	APC	1	105	352	50	150	9
56	APC	1	0	380	42	150	8
60	APC	1	0	381	47	148	8
64	APC	1	0	342	34	148	8
68	APC	1	0	336	28	147	8
72	APC	1	0	327	24	146	8
76	APC	1	0	316	23	145	8
80	APC	1	0	302	21	144	8
84	APC	1	0	320	27	142	8

Day	Type vehicle	Sequence number	Issued from theater reserve	Combat losses Temp	Combat losses Perm	Noncombat losses Temp	Noncombat losses Perm
88	APC	1	0	312	26	140	8
92	APC	1	0	303	28	137	8
4	APC	2	10	22	5	14	2
8	APC	2	10	154	37	46	6
12	APC	2	10	163	41	44	6
16	APC	2	10	173	42	46	6
20	APC	2	10	206	51	41	5
24	APC	2	10	150	34	41	5
28	APC	2	10	136	27	43	5
32	APC	2	10	144	28	42	5
36	APC	2	10	139	25	41	5
40	APC	2	10	133	23	47	6
44	APC	2	10	136	20	51	6
48	APC	2	10	146	20	54	6
52	APC	2	10	186	25	55	7
56	APC	2	0	186	17	53	6
60	APC	2	0	184	21	52	6
64	APC	2	0	169	14	51	6
68	APC	2	0	154	10	51	6
72	APC	2	0	151	10	51	6
76	APC	2	0	137	11	51	6
80	APC	2	0	133	8	50	6
84	APC	2	0	132	10	50	6
88	APC	2	0	133	11	49	6
92	APC	2	0	124	11	48	6
4	APC	3	16	8	3	5	0
8	APC	3	16	58	26	18	1
12	APC	3	16	65	29	19	1
16	APC	3	16	92	40	21	1
20	APC	3	16	139	57	20	1
24	APC	3	16	91	41	22	1
28	APC	3	16	77	35	22	1
32	APC	3	16	85	37	22	1
36	APC	3	16	79	34	22	1
40	APC	3	16	74	32	30	2
44	APC	3	16	67	27	35	2
48	APC	3	16	59	24	37	2
52	APC	3	16	88	31	38	2
56	APC	3	0	75	25	39	2
60	APC	3	0	92	30	38	2
64	APC	3	0	71	22	39	2
68	APC	3	0	59	17	39	2
72	APC	3	0	51	14	39	2
76	APC	3	0	52	14	39	2
80	APC	3	0	46	12	39	2
84	APC	3	0	58	17	39	2
88	APC	3	0	49	14	39	2
92	APC	3	0	52	16	39	2

Day	Type vehicle	Sequence number	Issued from theater reserve	Combat losses		Noncombat losses	
				Temp	Perm	Temp	Perm
4	APC	5	0	2	0	4	0
8	APC	5	0	18	4	15	1
12	APC	5	0	20	5	15	1
16	APC	5	0	28	6	17	1
20	APC	5	0	38	8	15	1
24	APC	5	0	25	6	16	1
28	APC	5	0	22	5	16	1
32	APC	5	0	24	5	16	1
36	APC	5	0	22	4	16	1
40	APC	5	0	20	4	22	1
44	APC	5	0	19	4	25	1
48	APC	5	0	17	3	26	2
52	APC	5	0	25	4	27	2
56	APC	5	0	22	3	26	1
60	APC	5	0	26	4	26	1
64	APC	5	0	21	3	26	1
68	APC	5	0	17	2	26	1
72	APC	5	0	15	2	26	1
76	APC	5	0	15	2	26	1
80	APC	5	0	13	1	26	1
84	APC	5	0	15	2	25	1
88	APC	5	0	14	2	25	1
92	APC	5	0	14	2	25	1
4	APC	6	0	7	1	4	0
8	APC	6	0	54	12	14	2
12	APC	6	0	81	16	14	2
16	APC	6	0	118	21	17	2
20	APC	6	0	146	26	15	2
24	APC	6	0	98	20	16	2
28	APC	6	0	91	17	17	2
32	APC	6	0	83	16	16	2
36	APC	6	0	107	18	15	2
40	APC	6	0	73	13	21	3
44	APC	6	0	79	13	24	3
48	APC	6	0	96	16	24	3
52	APC	6	0	108	16	23	3
56	APC	6	0	74	10	23	3
60	APC	6	0	73	10	24	3
64	APC	6	0	60	8	23	3
68	APC	6	0	49	6	24	3
72	APC	6	0	46	6	24	3
76	APC	6	0	43	6	23	3
80	APC	6	0	42	5	23	3
84	APC	6	0	46	6	22	3
88	APC	6	0	40	6	22	2
92	APC	6	0	43	6	22	2
4	APC	7	138	15	2	25	3
8	APC	7	138	172	26	92	11
12	APC	7	138	211	32	94	12
16	APC	7	138	291	42	104	13

Day	Type vehicle	Sequence number	Issued from theater reserve	Combat losses		Noncombat losses	
				Temp	Perm	Temp	Perm
20	APC	7	138	393	54	103	13
24	APC	7	138	246	34	107	14
28	APC	7	138	247	32	110	14
32	APC	7	138	285	35	110	14
36	APC	7	138	266	31	110	14
40	APC	7	138	296	29	162	19
44	APC	7	138	330	35	201	25
48	APC	7	138	308	31	211	25
52	APC	7	138	477	45	218	26
56	APC	7	0	432	33	219	25
60	APC	7	0	503	41	218	25
64	APC	7	0	477	30	219	25
68	APC	7	0	446	24	219	25
72	APC	7	0	433	22	220	25
76	APC	7	0	419	22	220	25
80	APC	7	0	401	19	220	25
84	APC	7	0	426	24	220	25
88	APC	7	0	409	23	220	25
92	APC	7	0	408	24	220	25
4	ARTY	1	0	0	0	0	0
8	ARTY	1	0	4	1	0	0
12	ARTY	1	0	5	2	0	0
16	ARTY	1	0	3	1	0	0
20	ARTY	1	0	4	1	0	0
24	ARTY	1	0	4	1	0	0
28	ARTY	1	0	4	1	0	0
32	ARTY	1	0	4	1	0	0
36	ARTY	1	0	5	1	0	0
40	ARTY	1	0	4	1	0	0
44	ARTY	1	0	4	1	0	0
48	ARTY	1	0	3	1	0	0
52	ARTY	1	0	7	2	0	0
56	ARTY	1	0	6	1	0	0
60	ARTY	1	0	8	2	0	0
64	ARTY	1	0	9	2	0	0
68	ARTY	1	0	8	2	0	0
72	ARTY	1	0	6	1	0	0
76	ARTY	1	0	5	1	0	0
80	ARTY	1	0	4	1	0	0
84	ARTY	1	0	4	1	0	0
88	ARTY	1	0	4	1	0	0
92	ARTY	1	0	3	1	0	0
4	ARTY	2	0	0	0	0	0
8	ARTY	2	0	3	1	0	0
12	ARTY	2	0	4	1	0	0
16	ARTY	2	0	4	1	0	0
20	ARTY	2	0	6	1	0	0
24	ARTY	2	0	5	1	0	0
28	ARTY	2	0	7	2	0	0

Day	Type vehicle	Sequence number	Issued from theater reserve	Combat losses Temp	Combat losses Perm	Noncombat losses Temp	Noncombat losses Perm
32	ARTY	2	0	8	2	0	0
36	ARTY	2	0	13	3	0	0
40	ARTY	2	0	11	3	0	0
44	ARTY	2	0	10	2	0	0
48	ARTY	2	0	9	2	0	0
52	ARTY	2	0	22	5	0	0
56	ARTY	2	0	15	4	0	0
60	ARTY	2	0	24	6	0	0
64	ARTY	2	0	24	6	0	0
68	ARTY	2	0	20	5	0	0
72	ARTY	2	0	16	4	0	0
76	ARTY	2	0	13	3	0	0
80	ARTY	2	0	12	3	0	0
84	ARTY	2	0	13	3	0	0
88	ARTY	2	0	13	3	0	0
92	ARTY	2	0	10	2	0	0
4	ARTY	3	22	3	1	0	0
8	ARTY	3	22	20	6	0	0
12	ARTY	3	22	27	8	0	0
16	ARTY	3	22	26	8	0	0
20	ARTY	3	22	34	9	0	0
24	ARTY	3	22	31	8	0	0
28	ARTY	3	22	31	8	0	0
32	ARTY	3	22	31	8	0	0
36	ARTY	3	22	39	10	0	0
40	ARTY	3	22	36	9	0	0
44	ARTY	3	22	31	8	0	0
48	ARTY	3	22	29	7	0	0
52	ARTY	3	22	62	15	0	0
56	ARTY	3	0	53	12	0	0
60	ARTY	3	0	74	17	0	0
64	ARTY	3	0	72	17	0	0
68	ARTY	3	0	54	13	0	0
72	ARTY	3	0	41	10	0	0
76	ARTY	3	0	34	8	0	0
80	ARTY	3	0	29	7	0	0
84	ARTY	3	0	30	7	0	0
88	ARTY	3	0	29	7	0	0
92	ARTY	3	0	23	5	0	0
4	ARTY	4	0	0	0	0	0
8	ARTY	4	0	0	0	0	0
12	ARTY	4	0	0	0	0	0
16	ARTY	4	0	0	0	0	0
20	ARTY	4	0	0	0	0	0
24	ARTY	4	0	0	0	0	0
28	ARTY	4	0	0	0	0	0
32	ARTY	4	0	0	0	0	0
36	ARTY	4	0	0	0	0	0
40	ARTY	4	0	0	0	0	0

Day	Type vehicle	Sequence number	Issued from theater reserve	Combat losses Temp	Combat losses Perm	Noncombat losses Temp	Noncombat losses Perm
44	ARTY	4	0	0	0	0	0
48	ARTY	4	0	0	0	0	0
52	ARTY	4	0	0	0	0	0
56	ARTY	4	0	0	0	0	0
60	ARTY	4	0	0	0	0	0
64	ARTY	4	0	0	0	0	0
68	ARTY	4	0	0	0	0	0
72	ARTY	4	0	0	0	0	0
76	ARTY	4	0	0	0	0	0
80	ARTY	4	0	0	0	0	0
84	ARTY	4	0	0	0	0	0
88	ARTY	4	0	0	0	0	0
92	ARTY	4	0	0	0	0	0
4	TANK	1	55	27	8	40	2
8	TANK	1	55	243	75	159	10
12	TANK	1	55	296	98	166	11
16	TANK	1	55	391	119	187	13
20	TANK	1	55	565	157	168	12
24	TANK	1	55	325	100	172	12
28	TANK	1	55	294	93	181	12
32	TANK	1	55	319	92	177	12
36	TANK	1	55	289	81	175	12
40	TANK	1	55	193	59	180	12
44	TANK	1	55	201	57	181	12
48	TANK	1	55	195	50	180	11
52	TANK	1	55	257	62	177	11
56	TANK	1	0	181	38	177	10
60	TANK	1	0	227	52	174	10
64	TANK	1	0	146	30	171	10
68	TANK	1	0	105	19	175	10
72	TANK	1	0	92	17	175	10
76	TANK	1	0	92	19	173	10
80	TANK	1	0	70	13	172	10
84	TANK	1	0	80	15	172	9
88	TANK	1	0	116	22	168	9
92	TANK	1	0	97	20	164	9
4	TANK	2	0	0	0	4	0
8	TANK	2	0	11	5	8	1
12	TANK	2	0	13	5	8	1
16	TANK	2	0	12	5	9	1
20	TANK	2	0	9	3	9	1
24	TANK	2	0	5	2	9	1
28	TANK	2	0	4	1	9	1
32	TANK	2	0	2	1	10	1
36	TANK	2	0	2	1	10	1
40	TANK	2	0	30	11	48	3
44	TANK	2	0	24	8	77	4
48	TANK	2	0	25	11	90	5
52	TANK	2	0	77	21	96	5

Day	Type vehicle	Sequence number	Issued from theater reserve	Combat losses Temp	Combat losses Perm	Noncombat losses Temp	Noncombat losses Perm
56	TANK	2	0	74	20	92	5
60	TANK	2	0	94	24	90	5
64	TANK	2	0	79	18	88	5
68	TANK	2	0	69	14	87	5
72	TANK	2	0	63	11	87	5
76	TANK	2	0	62	11	86	5
80	TANK	2	0	58	9	85	5
84	TANK	2	0	69	14	84	5
88	TANK	2	0	36	8	84	5
92	TANK	2	0	53	12	83	4
4	TANK	3	0	0	0	0	0
8	TANK	3	0	0	1	0	0
12	TANK	3	0	1	1	1	0
16	TANK	3	0	1	1	1	0
20	TANK	3	0	1	2	1	0
24	TANK	3	0	0	1	1	0
28	TANK	3	0	0	1	1	0
32	TANK	3	0	0	0	1	0
36	TANK	3	0	0	0	1	0
40	TANK	3	0	5	12	10	1
44	TANK	3	0	1	2	9	0
48	TANK	3	0	2	2	9	0
52	TANK	3	0	7	10	8	0
56	TANK	3	0	9	7	7	0
60	TANK	3	0	8	6	7	0
64	TANK	3	0	7	5	7	0
68	TANK	3	0	6	5	6	0
72	TANK	3	0	6	4	6	0
76	TANK	3	0	5	4	6	0
80	TANK	3	0	5	4	5	0
84	TANK	3	0	5	4	5	0
88	TANK	3	0	0	0	5	0
92	TANK	3	0	1	1	5	0
4	TANK	7	0	4	1	3	0
8	TANK	7	0	30	8	12	1
12	TANK	7	0	31	7	13	1
16	TANK	7	0	39	11	14	1
20	TANK	7	0	33	13	13	1
24	TANK	7	0	33	8	12	1
28	TANK	7	0	37	7	12	1
32	TANK	7	0	33	6	11	1
36	TANK	7	0	29	6	11	1
40	TANK	7	0	47	7	15	1
44	TANK	7	0	49	6	15	1
48	TANK	7	0	52	6	16	1
52	TANK	7	0	57	8	17	1
56	TANK	7	0	63	6	16	1
60	TANK	7	0	56	6	15	1
64	TANK	7	0	59	5	15	1

Day	Type vehicle	Sequence number	Issued from theater reserve	Combat losses		Noncombat losses	
				Temp	Perm	Temp	Perm
68	TANK	7	0	59	4	15	1
72	TANK	7	0	59	4	14	1
76	TANK	7	0	55	4	14	1
80	TANK	7	0	55	4	14	1
84	TANK	7	0	52	4	14	1
88	TANK	7	0	51	3	14	1
92	TANK	7	0	48	3	13	1
4	TANK	8	0	0	0	0	0
8	TANK	8	0	0	0	0	0
12	TANK	8	0	0	0	1	0
16	TANK	8	0	0	0	2	0
20	TANK	8	0	0	0	2	0
24	TANK	8	0	0	0	2	0
28	TANK	8	0	0	0	2	0
32	TANK	8	0	0	0	2	0
36	TANK	8	0	0	0	2	0
40	TANK	8	0	0	0	4	0
44	TANK	8	0	0	0	5	0
48	TANK	8	0	0	0	5	0
52	TANK	8	0	0	0	5	0
56	TANK	8	0	0	0	4	0
60	TANK	8	0	0	0	4	0
64	TANK	8	0	0	0	4	0
68	TANK	8	0	0	0	4	0
72	TANK	8	0	0	0	4	0
76	TANK	8	0	0	0	4	0
80	TANK	8	0	0	0	4	0
84	TANK	8	0	0	0	4	0
88	TANK	8	0	0	0	4	0
92	TANK	8	0	0	0	4	0

APPENDIX E

DATA CERTIFICATION

DEPARTMENT OF THE ARMY
U. S. ARMY MATERIEL SYSTEMS ANALYSIS ACTIVITY
Aberdeen Proving Ground, Maryland 21005-5071

REPLY TO ATTENTION OF

AMXSY-LM 29 APR 1991

MEMORANDUM FOR Director, U.S. Army Concepts Analysis Agency (CAA), ATTN: CSCA-MVD (MAJ Brown), 8120 Woodmont Avenue, Bethesda, MD 20814-2797

SUBJECT: Data Certification for The European Transportation Requirements for Backhaul of Personnel/Cargo (ETRANS) Study

1. Reference memorandum, CAA, CSCA-MVD, 29 Jun 90, subject: Request for Data to Support The European Transportation Requirements for Backhaul of Personnel/Cargo Study.

2 As described by the referenced message, end item maintenance distributions and maintenance node distributions are provided as an enclosure. The former describes the ultimate disposition of the end item, while the latter refers to the probability of going to each succeeding node from a given node in the retail maintenance structure. These distributions were based primarily on the VIC-CSS data base for RAM failures, and on SPARC combat damage data. Similarly, estimated total weights by echelon of replacement parts are also furnished, based on Field Exercise Data Collection information, Provisioning Master Record data, and SPARC combat damage results.

3. It is understood by AMSAA that these data will be used in the ETRANS Study, specifically to determine the transportation assets needed to evacuate end items, and to move line repairable units to rear echelons.

4. In compliance with HQ AMC policy, signature of this letter indicates certification by the head of this Activity, the Deputy Director or designated GO/SES that:

   a. The data are the best available within time and resource constraints.

   b. The caveats and limitations of the data concerning the conditions under which they were generated are clearly stated. For example, conditions for which they apply (day or night, stationary or moving target, target size, under which conditions substitutions have been made, etc.).

   c. To the best of the data providers' knowledge these data are appropriate for the intended application within the limitations and caveats stated.

AMXSY-LM
SUBJECT: Data Certification for the European Transportation Requirements for Backhaul of Personnel/Cargo (ETRANS) Study

5. These data may not be used in any other model or to support other analytical efforts without prior approval (in writing) from the certification authority.

6. The AMSAA point of contact is Gerald Nielsen, DSN 298-4974.

FOR THE DIRECTOR:

Encl
as

John J. McCarthy
JOHN J. MC CARTHY
Chief, Logistics and Readiness
Analysis division

CF:
Commander, U.S. Army Materiel Command, ATTN: AMCAE-PE (Dr. Chapin), 5001 Eisenhower Avenue, Alexandria, VA 22331-0001

END ITEM MAINTENANCE DISTRIBUTION DATA

	-----	combat		M1A1 ------	non-combat	
	temp	perm	(def)	temp	perm	(def)
abandoned		0.00	0.18		0.00	0.18
k-kill		0.80	0.67		0.00	0.00
field repair	0.06			0.17		
UMCP-org	0.17			0.52		
UMCP-ds	0.36			0.06		
UMCP-salvage		0.12	0.08		0.75	0.62
ORG(non CP)	0.06			0.17		
ORG-salvage		0.01	0.01		0.17	0.14
DS(non CP)	0.30			0.06		
DS-salvage		0.06	0.05		0.06	0.05
GS	0.05			0.02		
GS-salvage		0.01	0.01		0.02	0.01

	-----	combat		M113 ------	non-combat	
	temp	perm	(def)	temp	perm	(def)
abandoned		0.00	0.08		0.00	0.50
k-kill		0.80	0.72		0.00	0.00
field repair	0.15			0.16		
UMCP-org	0.45			0.49		
UMCP-ds	0.14			0.08		
UMCP-salvage		0.15	0.15		0.73	0.36
ORG(non CP)	0.15			0.16		
ORG-salvage		0.03	0.03		0.16	0.08
DS(non CP)	0.11			0.07		
DS-salvage		0.02	0.02		0.07	0.04
GS	0.00			0.04		
GS-salvage		0.00	0.00		0.04	0.02

	-----	combat		M2 ------	non-combat	
	temp	perm	(def)	temp	perm	(def)
abandoned		0.00	0.22		0.00	0.15
k-kill		0.80	0.62		0.00	0.00
field repair	0.08			0.18		
UMCP-org	0.25			0.53		
UMCP-ds	0.31			0.06		
UMCP-salvage		0.13	0.10		0.77	0.65
ORG(non CP)	0.08			0.17		
ORG-salvage		0.02	0.02		0.17	0.15
DS(non CP)	0.26			0.05		
DS-salvage		0.05	0.04		0.05	0.04
GS	0.02			0.01		
GS-salvage		0.00	0.00		0.01	0.01

NOTE: The "temp" heading refers to temporary losses. The other two columns both represent permanent losses. The column labeled "(def)" consists of losses suffered while in a defensive posture. Abandonment is assumed to occur only in the defense (consistent with the ASM COEA).

END ITEM MAINTENANCE DISTRIBUTION DATA

----- M109 ------

	combat			non-combat		
	temp	perm	(def)	temp	perm	(def)
abandoned		0.00	0.24		0.00	0.43
k-kill		0.80	0.61		0.00	0.00
field repair	0.18			0.20		
UMCP-org	0.52			0.58		
UMCP-ds	0.07			0.01		
UMCP-salvage		0.15	0.12		0.79	0.45
ORG(non CP)	0.13			0.20		
ORG-salvage		0.04	0.02		0.20	0.11
DS(non CP)	0.05			0.005		
DS-salvage		0.01	0.01		0.005	0.005
GS	0.00			0.005		
GS-salvage		0.00	0.00		0.005	0.005

----- HMMWV -----

	combat			non-combat		
	temp	perm	(def)	temp	perm	(def)
abandoned		0.00	0.38		0.00	0.50
k-kill		0.80	0.50		0.00	0.00
field repair	0.18			0.17		
UMCP-org	0.55			0.49		
UMCP-ds	0.02			0.08		
UMCP-salvage		0.15	0.09		0.74	0.37
ORG(non CP)	0.18			0.17		
ORG-salvage		0.04	0.02		0.17	0.08
DS(non CP)	0.02			0.06		
DS-salvage		0.00	0.00		0.06	0.03
GS	0.05			0.03		
GS-salvage		0.01	0.01		0.03	0.02

----- M60A3 -------

	combat			non-combat		
	temp	perm	(def)	temp	perm	(def)
abandoned		0.00	0.18		0.00	0.30
k-kill		0.80	0.66		0.00	0.00
field repair	0.06			0.19		
UMCP-org	0.17			0.55		
UMCP-ds	0.36			0.04		
UMCP-salvage		0.12	0.10		0.78	0.55
ORG(non CP)	0.06			0.19		
ORG-salvage		0.01	0.01		0.19	0.13
DS(non CP)	0.30			0.03		
DS-salvage		0.06	0.04		0.03	0.02
GS	0.05			0.00		
GS-salvage		0.01	0.01		0.00	

END ITEM MAINTENANCE DISTRIBUTION DATA

	M109					
	combat			non-combat		
	temp	perm	(def)	temp	perm	(def)
abandoned		0.00	0.24		0.00	0.43
k-kill		0.80	0.61		0.00	0.00
field repair	0.18			0.20		
UMCP-org	0.52			0.58		
UMCP-ds	0.07			0.01		
UMCP-salvage		0.15	0.12		0.79	0.45
ORG(non CP)	0.18			0.20		
ORG-salvage		0.04	0.02		0.20	0.11
DS(non CP)	0.05			0.005		
DS-salvage		0.01	0.01		0.005	0.005
GS	0.00			0.005		
GS-salvage		0.00	0.00		0.005	0.005

	HMMWV					
	combat			non-combat		
	temp	perm	(def)	temp	perm	(def)
abandoned		0.00	0.38		0.00	0.50
k-kill		0.80	0.50		0.00	0.00
field repair	0.18			0.17		
UMCP-org	0.55			0.49		
UMCP-ds	0.02			0.08		
UMCP-salvage		0.15	0.09		0.74	0.37
ORG(non CP)	0.18			0.17		
ORG-salvage		0.04	0.02		0.17	0.08
DS(non CP)	0.02			0.06		
DS-salvage		0.00	0.00		0.06	0.03
GS	0.05			0.03		
GS-salvage		0.01	0.01		0.03	0.02

	M60A3					
	combat			non-combat		
	temp	perm	(def)	temp	perm	(def)
abandoned		0.00	0.18		0.00	0.30
k-kill		0.80	0.66		0.00	0.00
field repair	0.06			0.19		
UMCP-org	0.17			0.55		
UMCP-ds	0.36			0.04		
UMCP-salvage		0.12	0.10		0.78	0.55
ORG(non CP)	0.06			0.19		
ORG-salvage		0.01	0.01		0.19	0.13
DS(non CP)	0.30			0.03		
DS-salvage		0.06	0.04		0.03	0.02
GS	0.05			0.00		
GS-salvage		0.01	0.01		0.00	

END ITEM MAINTENANCE DISTRIBUTION DATA

M901	combat temp	combat perm	combat (def)	non-combat temp	non-combat perm	non-combat (def)
abandoned		0.00	0.28		0.00	0.41
k-kill		0.80	0.58		0.00	0.00
field repair	0.06			0.17		
UMCP-org	0.19			0.50		
UMCP-ds	0.38			0.09		
UMCP-salvage		0.13	0.09		0.76	0.45
ORG(non CP)	0.06			0.17		
ORG-salvage		0.01	0.01		0.17	0.10
DS(non CP)	0.31			0.07		
DS-salvage		0.06	0.04		0.07	0.04
GS	0.00			0.00		
GS-salvage		0.00	0.00		0.00	0.00

M3	combat temp	combat perm	combat (def)	non-combat temp	non-combat perm	non-combat (def)
abandoned		0.00	0.21		0.00	0.16
k-kill		0.80	0.63		0.00	0.00
field repair	0.05			0.17		
UMCP-org	0.17			0.50		
UMCP-ds	0.38			0.09		
UMCP-salvage		0.12	0.10		0.76	0.64
ORG(non CP)	0.05			0.17		
ORG-salvage		0.01	0.01		0.17	0.14
DS(non CP)	0.31			0.07		
DS-salvage		0.06	0.05		0.07	0.06
GS	0.04			0.00		
GS-salvage		0.01	0.00		0.00	0.00

MLRS	combat temp	combat perm	combat (def)	non-combat temp	non-combat perm	non-combat (def)
abandoned		0.00	0.16		0.00	0.50
k-kill		0.80	0.67		0.00	
field repair	0.06			0.20		
UMCP-org	0.19			0.60		
UMCP-ds	0.13			0.00		
UMCP-salvage		0.08	0.06		0.80	0.40
ORG(non CP)	0.06			0.20		
ORG-salvage		0.01	0.01		0.20	0.10
DS(non CP)	0.10			0.00		
DS-salvage		0.02	0.02		0.00	0.00
GS	0.46			0.00		
GS-salvage		0.09	0.08		0.00	0.00

NOTE that 0.80 is a constant value for k-kill under permanent combat losses. This value is very scenario-dependent, and should be varied in sensitivity runs of the model. In order to adjust the other parameter values under permanent combat losses, multiply by the applicable value from temporary combat losses. This preserves the same relative distribution. For example, for the M2, the second column now reads: 0.00, 0.80, 0.13, 0.02, 0.05, 0.00. Changing 0.80 to 0.60 gives: 0.00, 0.60, 0.25, 0.03, 0.10, 0.01 (i.e., 0.25 = (1.00-0.60)*(0.08+0.25+0.31)).

NODE DISTRIBUTION DATA

	----- M1A1 ------	
	combat	RAM
UMCP-org rep	0.181	0.627
UMCP-ds rep	0.383	0.072
UMCP to org	0.091	0.238
UMCP to ds	0.345	0.064
ORG rep	0.701	0.862
ORG to ds	0.299	0.138
DS rep	0.857	0.750
DS to gs	0.143	0.250

	----- M113 ------	
	combat	RAM
UMCP-org rep	0.529	0.583
UMCP-ds rep	0.165	0.095
UMCP to org	0.214	0.229
UMCP to ds	0.092	0.092
ORG rep	0.825	0.831
ORG to ds	0.175	0.169
DS rep	1.000	0.636
DS to gs	0.000	0.364

	----- M2 ------	
	combat	RAM
UMCP-org rep	0.272	0.646
UMCP-ds rep	0.337	0.073
UMCP to org	0.121	0.234
UMCP to ds	0.271	0.046
ORG rep	0.720	0.885
ORG to ds	0.280	0.115
DS rep	0.929	0.833
DS to gs	0.071	0.167

NOTE: "UMCP-org rep" means organizational repair done at the unit maintenance collection point. "UMCP to org" means the proportion of end items moving from the UMCP to organizational maintenance.

NODE DISTRIBUTION DATA

	----- M109 ------	
	combat	RAM
UMCP-org rep	0.634	0.725
UMCP-ds rep	0.085	0.012
UMCP to org	0.243	0.256
UMCP to ds	0.037	0.007
ORG rep	0.902	0.977
ORG to ds	0.098	0.023
DS rep	1.000	0.500
DS to gs	0.000	0.500

	----- HMMWV -----	
	combat	RAM
UMCP-org rep	0.671	0.590
UMCP-ds rep	0.024	0.096
UMCP to org	0.250	0.240
UMCP to ds	0.055	0.073
ORG rep	0.877	0.852
ORG to ds	0.123	0.148
DS rep	0.286	0.667
DS to gs	0.714	0.333

	----- M60A3 -------	
	combat	RAM
UMCP-org rep	0.181	0.679
UMCP-ds rep	0.383	0.049
UMCP to org	0.091	0.251
UMCP to ds	0.345	0.021
ORG rep	0.701	0.936
ORG to ds	0.299	0.064
DS rep	0.857	1.000
DS to gs	0.143	0.000

NODE DISTRIBUTION DATA

	----- M901 -------	
	combat	RAM
UMCP-org rep	0.202	0.602
UMCP-ds rep	0.404	0.108
UMCP to org	0.091	0.235
UMCP to ds	0.303	0.054
ORG rep	0.705	0.873
ORG to ds	0.295	0.127
DS rep	1.000	1.000
DS to gs	0.000	0.000

	----- M3 -------	
	combat	RAM
UMCP-org rep	0.179	0.602
UMCP-ds rep	0.400	0.108
UMCP to org	0.076	0.235
UMCP to ds	0.345	0.054
ORG rep	0.696	0.873
ORG to ds	0.304	0.127
DS rep	0.886	1.000
DS to gs	0.114	0.000

	----- MLRS ------	
	combat	RAM
UMCP-org rep	0.202	0.750
UMCP-ds rep	0.138	0.000
UMCP to org	0.093	0.250
UMCP to ds	0.567	0.000
ORG rep	0.689	1.000
ORG to ds	0.311	0.000
DS rep	0.179	1.000
DS to gs	0.821	0.000

WEIGHT DATA

Part Weight in pounds per Reparable Combat Damaged Vehicle

	Crew	Organizational	Direct support	General Support	Depot
M1A1	10	65	415	60	1350
M2 / M3		5	50		15
M60A3		40	110	105	860
M113A2		10	10	130	
M109A2		95		25	640
M110A2		110	70		70
M270(MLRS)		85	5	95	175

Part Weight in pounds per RAM Failure

	Organizational	Direct support	General Support	Depot
M1A1	10	30	5	715
M2	80	35	90	40
M3	140	30	55	35
M60A3	330	205	105	195
M113A2	80	25	350	15
M109A2	25	25	220	5
M901	20	10	135	5

Helicopters (factor to be applied against M1A1 RAM total weight)

PFCA	0.58	0.95	-	0.21
PFAS	0.45	0.74	-	0.16

APPENDIX F

HET ANALYSIS SPREADSHEET DESCRIPTION

F-1. GENERAL. The HET analysis spreadsheet described herein and referenced in the study is provided as Annex I to this appendix. The spreadsheet cell formulas for the example in Annex I are provided in Annex II. Representatives of the Army Material Systems Analysis Agency and the US Army Transportation School have reviewed the format and provided data in their areas of expertise. The spreadsheet portrays Army battlefield recovery and evacuation doctrine as described in Field Manual (FM) 63-2 and FM 63-20.

F-2. PURPOSE. The purpose of this appendix is to describe the spreadsheet that is used to translate maintenance data into transportation requirements for the transport of tracked vehicles. The intent is to respond to specific concerns expressed by DAODCSLOG that HET units in USAREUR are not assigned on the basis of a validated workload.

F-3. HET SPREADSHEET DESCRIPTION

a. Vehicle Distribution. The spreadsheet contains 24 possible maintenance alternatives that start from the point at which the vehicle becomes disabled. Probability values for the vehicle distribution were provided by AMSAA.

(1) The first three alternatives, "abandoned," "K-Kill," and "battlefield repair" represent vehicles that are not recovered. All other vehicles are recovered to the unit maintenance CP.

(2) Some vehicles are repaired at the CP and return to the FEBA under their own power. A schematic of the subsequent maintenance alternatives starting at the CP is provided in Figure F-1.

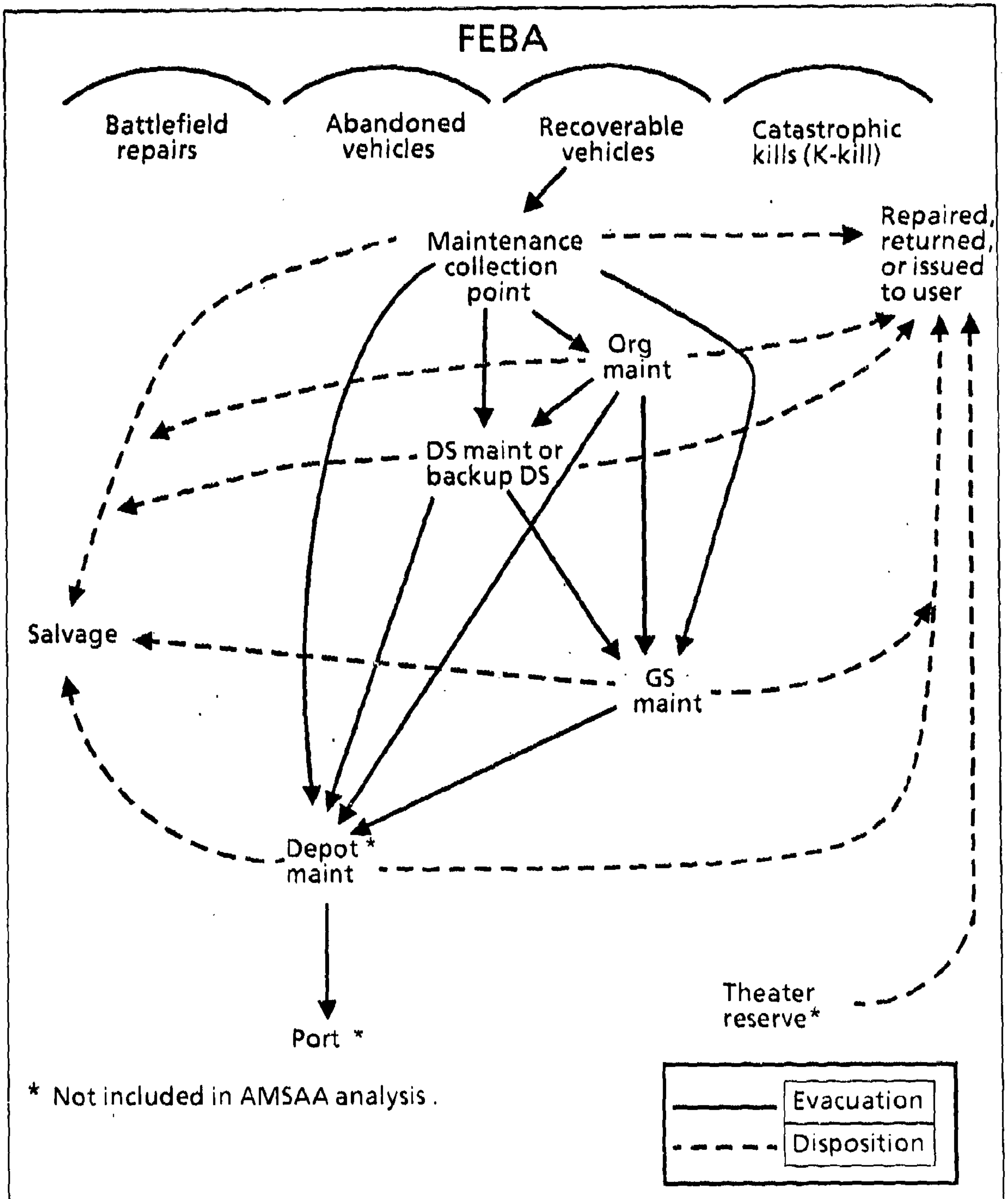

Figure F-1. HET Analysis Schematic

(3) Once recovered to the CP, the vehicles are distributed among the distribution alternatives until final disposition is either "repair" for temporary damage or "salvage" for permanent damage. An example of the weights of a distribution determined by AMSAA extracted from Appendix C is provided in Table F-1. Formulas were entered for some values to better portray transportation realities. For example, AMSAA data does not reflect that a percentage of vehicles will be handled twice, e.g., CP to Org and then Org to DS. Vehicles that are salvaged at Org, DS, or GS are processed and transported as if they were considered repairable by technical inspectors at the CP.

b. Combat Loss Data. Four-day accumulations of combat loss data for tracked vehicles are generated by the PFCAE-96 and PFASS Concepts Evaluation Model. The results are listed in the model Logistics Report by type and model of equipment (see Appendix D). The data is divided into combat damage (results of enemy action) and noncombat RAM failures. Both combat damage and noncombat failures are subdivided into "temporary" and "permanent" categories. Temporary combat and temporary RAM failures are, by definition, repairable. Permanent combat damage and permanent RAM failures are, by definition, not repairable. For example, if there were 200 temporary combat damaged vehicles and 50 temporary RAM failures, a total population of 250 vehicles would be repaired at various maintenance levels. Likewise, a total of 125 vehicles would be abandoned or salvaged if 100 permanently combat damaged vehicles and 25 permanent RAM failures were identified. There is no switching between the temporary and permanent categories as the vehicles move through the maintenance process.

Table F-1. Sample Data for a Tracked Vehicle

Event	Maintenance distribution					
	Combat damage			Noncombat damage		
	Temporary	Permanent	Permanent (defense)	Temporary	Permanent	Permanent (defense)
Abandoned		.00	.18		.00	.18
K-kill		.80	.67		.00	.00
Field repair	.06			.17		
UMCP - Org	.17			.52		
- DS	.36			.06		
- Salvage		.12	.08		.75	.62
Org (non-CP)	.06			.17		
Org salvage		.01	.01		.17	.14
DS (non-CP)	.30			.06		
DS salvage		.06	.05		.06	.05
GS	.05			.02		
GS salvage		.01	.01		.02	.01
Total	1.00	1.00	1.00	1.00	1.00	1.00

Event	Node distribution	
	Combat damage	Noncombat damage
UMCP - Org Repair	.181	.627
UMCP - DS Repair	.383	.072
UMCP to Org	.091	.238
UMCP to DS	.345	.064
Total	1.000	1.000
Org Repair	.701	.862
Org to DS	.299	.138
Total	1.000	1.000
DS Repair	.857	.750
DS to GS	.143	.250
Total	1.000	1.000

c. **Maintenance Workload.** The combat loss data is multiplied by the maintenance distribution to derive the maintenance workload for the population. The column on the right totals the maintenance workload for each vehicle alternative.

d. **Disposition.** When the disposition of the maintenance population is known, transportation requirements can be calculated. The figures for both combat and noncombat loss can be aggregated because from a transportation viewpoint, there is no difference between combat and noncombat damaged vehicles needing evacuation. The results can be multiplied by the transportation distribution provided by the US Army Transportation School, Ft Eustis, VA, to determine the total number of vehicles requiring HET transportation for each alternative. The M113 APC is not weight restricted to a HET; also, a HET is capable of carrying two M113s per load. But all combat damaged or inoperable tracked vehicles, including the M113, require a HET for evacuation because of its winch capability. Only one vehicle that is winched aboard the HET can be carried at a time.

e. **Transportation Distribution.** Movements are divided between highway and rail considering the percentages in AFPDA as shown in Table F-2. Damaged tanks, artillery, and armored personnel carriers moving forward or in retrograde are not expected to be transported by aircraft in any LR in Europe; therefore, the air portion is allocated to highway and rail. Similarly, once a tracked vehicle is on either a HET or rail car, little advantage accrues if it is transloaded to waterway in the RCZ or COMMZ. Values used in the study different from those in AFPDA are shown in parenthesis.

Table F-2. Distribution of Transportation Mode - AFPDA Europe (percent)

Mode	Division	Corps	RCZ	COMMZ
Major end items by highway	95(100)	25(30)	20(25)	25
Major end items by rail	0	65(70)	70(75)	70(75)
Major end items by AF air	5(0)	10(0)	5(0)	0
Major end items by waterway	0	0	5(0)	5(0)

(1) The transportation distribution spreadsheet alternative 15, DS evacuation to GS, provides an application of the transportation mode distribution percentages. Thirty percent of the vehicles will be transported from origin (the division DS unit) to destination (the GS facility in the RCZ or COMMZ) by HET over distances requiring a line haul. The remaining 70 percent of the tracked vehicles will be transported by truck to the corps rear (considered a local haul) for loading onto rail cars for transport to the general support facility. The study estimates that only half of the GS facilities in the European theater will be directly accessible by rail. As a result, half of the vehicles going to GS by rail will need a local haul from the destination railhead to the GS maintenance facility. Therefore, for every 100 tracked vehicles evacuated from DS to GS, 105 local hauls (70 at origin + 35 at destination = 105) and 30 line hauls will be performed using HETs.

(2) Based on the total local and line haul requirements to support the population of vehicles for the 4-day period, the number of heavy truck companies can be calculated for both the division and the corps/theater areas. The computation is based on 24 trucks/company having an average 75 percent availability rate and operating two shifts/day. Each shift can do 2 local hauls per truck or one line haul per truck.

f. Transportation Requirements. Maintenance disposition figures are multiplied by the transportation distribution factors to derive transportation requirements.

g. Backhaul Potential

(1) There is no backhaul potential in the division because all vehicles in the division area move toward the FEBA using their own power.

(2) Only certain spreadsheet alternatives have possible HET backhauls: line haul for alternatives number 15 with number 18, and number 16 with number 21; local haul for alternatives number 15 and number 16, with number 18, number 19, number 21, and number 24. Figure F-2 depicts the alternatives that have a backhaul potential and the percentage of the occurrences a particular alternative is judged to be a HET local/line haul.

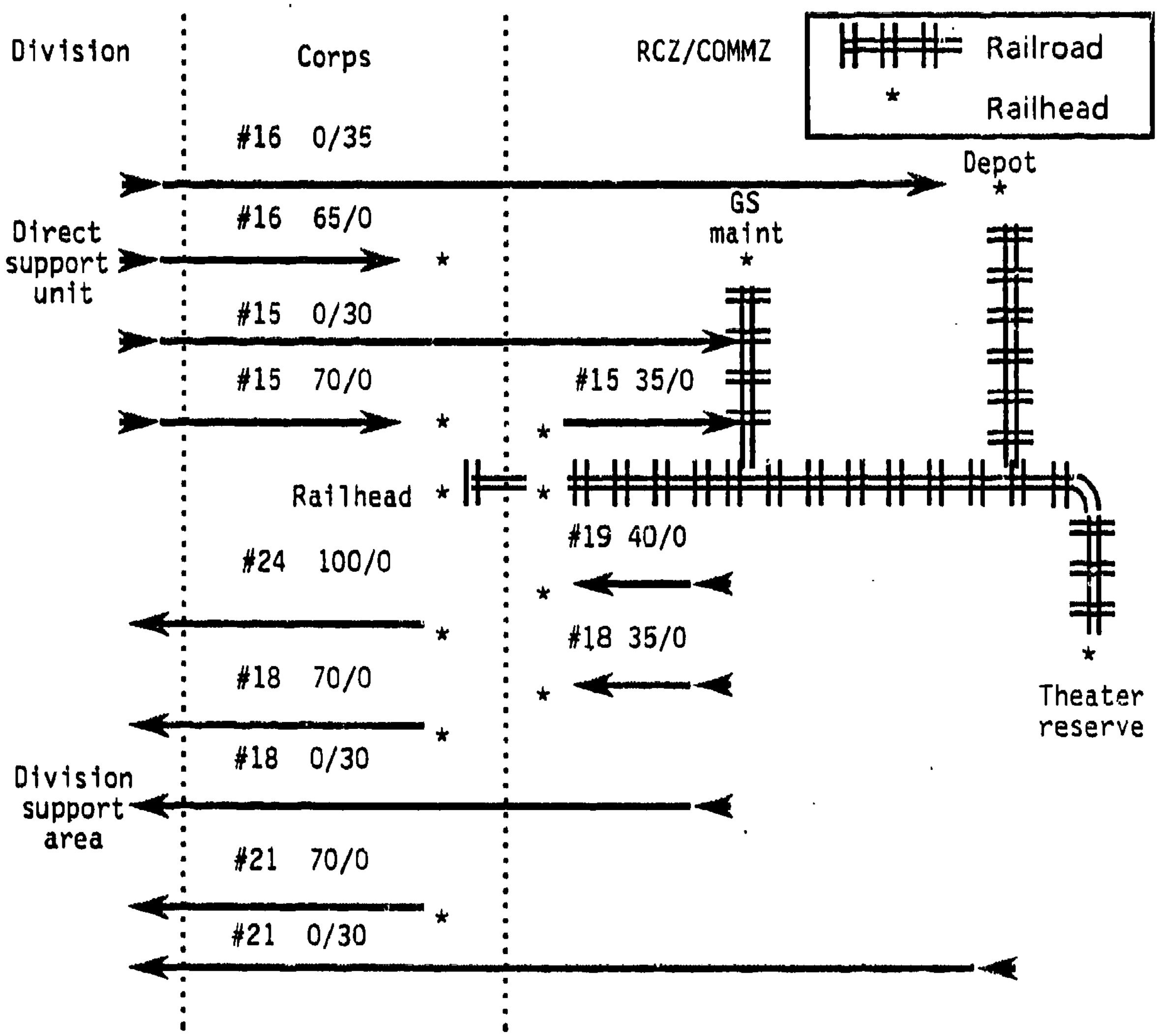

Figure F-2. HET Backhaul Potential

(3) Backhauls are calculated by determining which alternatives have similar or identical HET transport requirements in opposite directions: for example, between GS maintenance and the RCZ/COMMZ railhead in Figure F-2. Choose the lowest number between the value of number 15 and the sum of number 18, number 19, and number 21 to determine the number of HET backhauls possible on that route. The remainder will be trips in which the HET will transport vehicles only in one direction.

(4) Backhauls can be two-point (origin to destination to origin) or three-point (origin to destination to second destination to origin). Four point backhauls are possible, but the potential for the HET appears low, and the spatial relationships among origin and the several destinations are difficult to assess for study purposes.

g. Results

(1) The results listed support the HET analysis in Chapter 2. The excursions in Chapter 3 are easily made by either adjusting the maintenance or transportation distributions. For example, the spreadsheet could analyze the HET requirements if rail was unavailable by zeroing all values for rail and adjusting the percentages for local and line hauls in the transportation distribution.

(2) Truck company results are in terms of 24 truck companies (18 operational vehicles). Adjustment to an 18-truck company is possible by multiplying the number of 24 truck companies by 1.33. The anticipated size of the 1997 Program Objective Memorandum (POM) heavy truck company is 36 trucks. Adjustment to the 36-truck company is made by dividing the number of 24-truck companies by 1.5.

(3) Backhaul results are derived directly from backhaul calculations described in paragraph F-3.

ANNEX I TO APPENDIX F

SAMPLE ETRANS HET ANALYSIS SPREADSHEET

VEHICLE DISTRIBUTION		COMBAT LOSSES TEMP	COMBAT LOSSES PERM	NON-COMBAT LOSSES TEMP	NON-COMBAT LOSSES PERM	
1. Abandoned			0%		0%	
2. K-Kill			80%			
3. Battlefield Repair		18%		20%		
4. Repair at Maint CP		59%		59%		
5. CP Transfer to ORG		23%	3%	20%	20%	
6. CP Evacution to DS		1%	2%	1%	1%	
7. CP Evacution to GS		0%	0%	0%	0%	
8. CP EVAC to Depot		0%	0%	0%	0%	
9. CP to Salvage			15%		79%	
TOTAL		100%	100%	100%	100%	
10. ORG Repair		78%		97%		
11. Org EVAC to DS		22%	0%	3%	3%	
12. ORG to Salvage			100%		97%	
TOTAL		100%	100%	100%	100%	
13. DS Repair		100%		25%		
14. DS EVAC to Backup DS		0%	0%	0%	0%	
15. DS Evacution to GS		0%	0%	75%	75%	
16. DS EVAC to Depot		0%	0%	0%	0%	
17. DS to Salvage			100%		25%	
TOTAL		100%	100%	100%	100%	
18. GS Repair		100%		100%		
19. GS EVAC to Depot		0%	0%	0%	0%	
20. GS to Salvage			100%		100%	
TOTAL		100%	100%	100%	100%	
21. Depot Repair		100%		100%		
22. Depot to Port		0%	0%	0%	0%	
23. Depot to Salvage			100%		100%	
TOTAL		100%	100%	100%	100%	
24. Theater Reserve to unit		55				55
COMBAT LOSS DATA	55	800	400	200	40	1440

NOTE: rounding to nearest percent may cause component numbers not to sum to total.

MAINTENANCE WORKLOAD

1. Abandoned	0.0	0.0	0.0	0.0	0.0
2. K-Kill	0.0	320.0	0.0	0.0	320.0
3. Battlefield Repair	144.0	0.0	40.0	0.0	184.0
4. Repair at Maint CP	472.0	0.0	118.0	0.0	590.0
5. CP Transfer to ORG	180.0	10.0	40.8	8.2	239.0
6. CP Evacution to DS	4.0	10.0	1.2	0.2	15.4
7. CP Evacution to GS	0.0	0.0	0.0	0.0	0.0
8. CP EVAC to Depot	0.0	0.0	0.0	0.0	0.0
9. CP to Salvage	0.0	60.0	0.0	31.6	91.6
TOTAL	800.0	400.0	200.0	40.0	1440.0
10. ORG Repair	140.4	0.0	39.6	0.0	180.0
11. Org EVAC to DS	39.6	0.0	1.2	0.2	41.0
12. Org to Salvage	0.0	10.0	0.0	7.9	17.9
13. DS Repair	43.6	0.0	0.6	0.0	44.2
14. DS EVAC to Backup DS	0.0	0.0	0.0	0.0	0.0
15. DS Evacution to GS	0.0	0.0	1.8	0.4	2.1
16. DS EVAC to Depot	0.0	0.0	0.0	0.0	0.0
17. DS to Salvage	0.0	10.0	0.0	0.1	56.5
18. GS Repair	0.0	0.0	1.8	0.0	1.8
19. GS EVAC to Depot	0.0	0.0	0.0	0.0	0.0
20. GS to Salvage	0.0	0.0	0.0	0.4	2.1
21. Depot Repair	0.0	0.0	0.0	0.0	0.0
22. Depot to Port	0.0	0.0	0.0	0.0	0.0
23. Depot to Salvage	0.0	0.0	0.0	0.0	0.0
24. Theater Reserve to unit	55				

DISPOSITION			MULTIPLY HANDLED VEHICLES (RUNNING TOTAL)	RETRO MOVEMENTS (RUNNING TOTAL)	FINAL DISPOSITN (RUNNING TOTAL)
1. Abandoned	·0.0				
2. K-Kill	320.0				
3. Battlefield Repair	184.0				
4. Repair at Maint CP	590.0				
TOTALS	1094.0	1094.0			1094.0
5. CP Transfer to ORG	239.0			239.0	
6. CP Evacution to DS	15.4			254.4	
7. CP Evacution to GS	0.0			254.4	
8. CP EVAC to Depot	0.0			254.4	
9. CP to Salvage	91.6				1185.6
TOTALS	346.0	346.0			
		1440.0			
10. ORG Repair	180.0				1365.6
11. Org EVAC to DS			41.0	295.4	
12. Org to Salvage	17.9				1383.5
13. DS Repair	44.2				1427.7
14. DS EVAC to Backup DS			0.0	295.4	
15. DS EVAC to GS			2.1	297.5	
16. DS EVAC to Depot			0.0	297.5	
17. DS to Salvage	10.1				1437.9
18. GS Repair	1.8				1439.6
19. GS EVAC to Depot			0.0	297.5	
20. GS to Salvage	0.4				1440.0
21. Depot Repair	0.0				1440.0
22. Depot to Port			0.0	297.5	1440.0
23. Depot to Salvage	0.0				1440.0
TOTALS	0.0		43.1		
24. Theater Reserve to Unit	55			352.5	

TRANSPORTATION DISTRIBUTION

	LCL	LINE	RAIL	CODES
1. Abandoned	0%	0%	0%	
2. K-Kill	0%	0%	0%	
3. Battlefield Repair	0%	0%	0%	
4. Repair at Maint CP	0%	0%	0%	
5. CP Transfer to ORG	100%	0%	0%	D
6. CP Evacution to DS	60%	40%	0%	D
7. CP Evacution to GS	0%	0%	0%	
8. CP EVAC to Depot	0%	0%	0%	
9. CP to Salvage	0%	0%	0%	
10. Organizational Repair				
11. Org Evacuation to DS	100%	0%	0%	D
12. Org to Salvage	0%	0%	0%	
13. DS Repair	0%	0%	0%	F
14. DS EVAC to Backup DS	0%	0%	0%	
15. DS Evacution to GS	105%	30%	70%	
16. DS Evacution to Depot	65%	35%	65%	
17. DS to Salvage				
18. GS Repair	105%	30%	70%	F
19. GS Evacution to Depot	120%	20%	80%	
20. GS to Salvage				
21. Depot Repair	105%	30%	70%	F
22. Depot to Port	120%	20%	80%	
23. Depot to Salvage				
24. Theater Reserve to Unit	100%	0%	100%	F

TRANSPORTATION REQUIREMENTS	TOTAL	LCL	LINE	RAIL	CODES
1. Abandoned	0.0	0.0	0.0	0.0	
2. K-Kill	0.0	0.0	0.0	0.0	
3. Battlefield Repair	0.0	0.0	0.0	0.0	
4. Repair at Maint CP	0.0	0.0	0.0	0.0	
5. CP Transfer to ORG	239.0	239.0	0.0	0.0	D
6. CP Evacution to DS	15.4	9.3	6.2	0.0	D
7. CP Evacution to GS	0.0	0.0	0.0	0.0	
8. CP EVAC to Depot	0.0	0.0	0.0	0.0	
9. CP to Salvage	0.0	0.0	0.0	0.0	
10. Organizational Repair	0.0	0.0	0.0	0.0	
11. Org Evacuation to DS	41.0	41.0	0.0	0.0	D
12. Org to Salvage	0.0	0.0	0.0	0.0	
13. DS Repair	0.0	0.0	0.0	0.0	F
14. DS EVAC to Backup DS	0.0	0.0	0.0	0.0	
15. DS Evacution to GS	2.9	2.2	0.6	1.5	
16. DS Evacution to Depot	0.0	0.0	0.0	0.0	
17. DS to Salvage	0.0	0.0	0.0	0.0	
18. GS Repair	2.4	1.9	0.5	1.2	F
19. GS Evacution to Depot	0.0	0.0	0.0	0.0	
20. GS to Salvage	0.0	0.0	0.0	0.0	
21. Depot Repair	0.0	0.0	0.0	0.0	F
22. Depot to Port	0.0	0.0	0.0	0.0	
23. Depot to Salvage	0.0	0.0	0.0	0.0	
24. Theater Reserve to Unit	55.0	55.0	0.0	55.0	F
	355.7				

	TOTAL	LCL	LINE	RAIL
TOTAL HET RETROGRADE	298.3	291.5	6.8	57.7
TOTAL HET FORWARD	57.4	56.9	0.5	56.2
TOTAL LIFTS	355.7	348.3	7.3	114.0

LIFTS BY LR DESTINATION	TOTAL	LOCAL	LINE	HET COS	DIV
LR 1 (DIV)	295.4	289.2	6.2	1.05	1.05
LR 2 (CORPS)	0.0	0.0	0.0	0.00	
LR 3 (RCZ)	2.9	2.2	0.6	0.01	CORPS/TH
LR 4 (COMMZ)	57.4	56.9	0.5	0.20	0.21
TOTAL CORPS/TH	60.3	59.1	1.2		
TOTAL		348.3	7.3	1.26	
			355.7		

ANNEX II TO APPENDIX F

CELL FORMULAS FOR HET ANALYSIS SPREADSHEET

```
C1: 'ETRANS HET ANALYSIS SPREADSHEET
A3: 'VEHICLE DISTRIBUTION
D3: "     COMBAT LOSSES
F3: "  NON-COMBAT LOSSES
A4: '------------------
D4: "TEMP
E4: "PERM
F4: "TEMP
G4: "PERM
A5: '1.   Abandoned
E5: (P0) 0
G5: (P0) 0
A6: '2.   K-Kill
E6: (P0) 0.8
A7: '3.   Battlefield Repair
D7: (P0) 0.18
F7: (P0) 0.2
A8: '4.   Repair at Maint CP
D8: (P0) 0.59
F8: (P0) 0.59
A9: '5.   CP Transfer to ORG
D9: (P0) 0.18*1.25
E9: (P0) 0.02*1.25
F9: (P0) 0.2*1.02
G9: (P0) 0.2*1.02
A10: '6.   CP Evacution to DS
D10: (P0) 1-D7-D8-D9
E10: (P0) 1-E5-E6-E9-E13
F10: (P0) 1-F7-F8-F9
G10: (P0) 1-G5-G9-G13
A11: '7.   CP Evacution to GS
D11: (P0) 0
E11: (P0) 0
F11: (P0) 0
G11: (P0) 0
A12: '8.   CP EVAC to Depot
D12: (P0) 0
E12: (P0) 0
F12: (P0) 0
G12: (P0) 0
A13: '9.   CP to Salvage
E13: (P0) 0.15
G13: (P0) 0.79
B14: 'TOTAL
D14: (P0) @SUM(D5..D13)
E14: (P0) @SUM(E5..E13)
F14: (P0) @SUM(F5..F13)
G14: (P0) @SUM(G5..G13)
A16: '10. ORG Repair
D16: (P0) 0.78
F16: (P0) +F9/(F9+F10)
A17: '11. Org EVAC to DS
D17: (P0) 0.27
E17: (P0) 0
F17: (P0) 1-F16
G17: (P0) 0.[illegible]
```

```
A18: '12. ORG to Salvage
E18: (PO) 1
G18: (PO) 0.97
B19: 'TOTAL
D19: (PO) @SUM(D16..D18)
E19: (PO) @SUM(E16..E18)
F19: (PO) @SUM(F16..F18)
G19: (PO) @SUM(G16..G18)
A21: '13. DS Repair
D21: (PO) 1
F21: (PO) 0.25
A22: '14. DS EVAC to Backup DS
D22: (PO) 0
E22: (PO) 0
F22: (PO) 0
G22: (PO) 0
A23: '15. DS Evacution to GS
D23: (PO) 0
E23: (PO) 0
F23: (PO) 0.75
G23: (PO) 0.75
A24: '16. DS EVAC to Depot
D24: (PO) 0
E24: (PO) 0
F24: (PO) 0
G24: (PO) 0
A25: '17. DS to Salvage
E25: (PO) 1
G25: (PO) 0.25
B26: 'TOTAL
D26: (PO) @SUM(D21..D25)
E26: (PO) @SUM(E21..E25)
F26: (PO) @SUM(F21..F25)
G26: (PO) @SUM(G21..G25)
A28: '18. GS Repair
D28: (PO) 1
F28: (PO) 1
A29: '19. GS EVAC to Depot
D29: (PO) 0
E29: (PO) 0
F29: (PO) 0
G29: (PO) 0
A30: '20. GS to Salvage
E30: (PO) 1
G30: (PO) 1
B31: (PO) 'TOTAL
D31: (PO) @SUM(D28..D30)
E31: (PO) @SUM(E28..E30)
F31: (PO) @SUM(F28..F30)
G31: (PO) @SUM(G28..G30)
A33: '21. Depot Repair
D33: (PO) 1
F33: (PO) 1
A34: '22. [illegible]
D34: (PO) 0
E34: (PO) 0
```

```
F34: (P0) 0
G34: (P0) 0
A35: '23. Depot to Salvage
E35: (P0) 1
G35: (P0) 1
B36: 'TOTAL
D36: (P0) @SUM(D33..D35)
E36: (P0) @SUM(E33..E35)
F36: (P0) @SUM(F33..F35)
G36: (P0) @SUM(G33..G35)
A38: '24. Theater Reserve to unit
D38: (F0) +C40
H38: (F0) +D38
A39: '______________________________
A40: (F0) 'COMBAT LOSS DATA
C40: (F0) 55
D40: (F0) 800
E40: (F0) 400
F40: (F0) 200
G40: (F0) 40
H40: (F0) @SUM(D40..G40)
A41: '------------------------------
A42: 'MAINTENANCE WORKLOAD
A43: "--------------------
A44: '1.  Abandoned
D44: (F1) +D40*D5
E44: (F1) +E40*E5
F44: (F1) +F40*F5
G44: (F1) +G40*G5
H44: (F1) @SUM(D44..G44)
A45: '2.  K-Kill
D45: (F1) +D40*D6
E45: (F1) +E40*E6
F45: (F1) +F40*F6
G45: (F1) +G40*G6
H45: (F1) @SUM(D45..G45)
A46: '3.  Battlefield Repair
D46: (F1) +D40*D7
E46: (F1) +E40*E7
F46: (F1) +F40*F7
G46: (F1) +G40*G7
H46: (F1) @SUM(D46..G46)
A47: '4.  Repair at Maint CP
D47: (F1) +D40*D8
E47: (F1) +E40*E8
F47: (F1) +F40*F8
G47: (F1) +G40*G8
H47: (F1) @SUM(D47..G47)
A48: '5.  CP Transfer to ORG
D48: (F1) +D40*D9
E48: (F1) +E40*E9
F48: (F1) +F40*F9
G48: (F1) +G40*G9
[illegible]
A49: '6.  CP Evacution to DS
D49: (F1) +D40*D10
```

```
E49: (F1) +E40*E10
F49: (F1) +F40*F10
G49: (F1) +G40*G10
H49: (F1) @SUM(D49..G49)
A50: '7.  CP Evacution to GS
D50: (F1) +D40*D11
E50: (F1) +E40*E11
F50: (F1) +F40*F11
G50: (F1) +G40*G11
H50: (F1) @SUM(D50..G50)
A51: '8.  CP EVAC to Depot
D51: (F1) +D40*D12
E51: (F1) +E40*E12
F51: (F1) +F40*F12
G51: (F1) +G40*G12
H51: (F1) @SUM(D51..G51)
A52: '9.  CP to Salvage
D52: (F1) +D40*D13
E52: (F1) +E40*E13
F52: (F1) +F40*F13
G52: (F1) +G40*G13
H52: (F1) @SUM(D52..G52)
B53: 'TOTAL
D53: (F1) @SUM(D44..D52)
E53: (F1) @SUM(E44..E52)
F53: (F1) @SUM(F44..F52)
G53: (F1) @SUM(G44..G52)
H53: (F1) @SUM(H44..H52)
C54: |::
A55: '10. ORG Repair
D55: (F1) +D48*D16
E55: (F1) +E48*E16
F55: (F1) +F48*F16
G55: (F1) +G48*G16
H55: (F1) @SUM(D55..G55)
A56: '11. Org EVAC to DS
D56: (F1) +D48*D17
E56: (F1) +E48*E17
F56: (F1) +F48*F17
G56: (F1) +G48*G17
H56: (F1) @SUM(D56..G56)
A57: '12. Org to Salvage
D57: (F1) +D48*D18
E57: (F1) +E48*E18
F57: (F1) +F48*F18
G57: (F1) +G48*G18
H57: (F1) @SUM(D57..G57)
A59: '13. DS Repair
D59: (F1) (D49+D56)*D21
E59: (F1) (E49+E56)*E21
F59: (F1) (F49+F56)*F21
G59: (F1) (G49+G56)*G21
H59: (F1) @SUM(D59..G59)
A60: '14. DS EVAC to [illegible]
D60: (F1) (D49+D56)*D22
E60: (F1) (E49+E56)*E22
```

```
F60: (F1) (F49+F56)*F22
G60: (F1) (G49+G56)*G22
H60: (F1) @SUM(D60..G60)
A61: '15. DS Evacution to GS
D61: (F1) (D49+D56)*D23
E61: (F1) (E49+E56)*E23
F61: (F1) (F49+F56)*F23
G61: (F1) (G49+G56)*G23
H61: (F1) @SUM(D61..G61)
A62: '16. DS EVAC to Depot
D62: (F1) (D49+D56)*D24
E62: (F1) (E49+E56)*E24
F62: (F1) (F49+F56)*F24
G62: (F1) (G49+G56)*G24
H62: (F1) @SUM(D62..G62)
A63: '17. DS to Salvage
D63: (F1) (D49+D56)*D25
E63: (F1) (E49+E56)*E25
F63: (F1) (F49+F56)*F25
G63: (F1) (G49+G56)*G25
H63: (F1) @SUM(D63..G63)
A65: '18. GS Repair
D65: (F1) (D50+D61)*D28
E65: (F1) (E50+E61)*E28
F65: (F1) (F50+F61)*F28
G65: (F1) (G50+G61)*G28
H65: (F1) @SUM(D65..G65)
A66: '19. GS EVAC to Depot
D66: (F1) (D50+D61)*D29
E66: (F1) (E50+E61)*E29
F66: (F1) (F50+F61)*F29
G66: (F1) (G50+G61)*G29
H66: (F1) @SUM(D66..G66)
A67: '20. GS to Salvage
D67: (F1) (D50+D61)*D30
E67: (F1) (E50+E61)*E30
F67: (F1) (F50+F61)*F30
G67: (F1) (G50+G61)*G30
H67: (F1) @SUM(D67..G67)
A69: '21. Depot Repair
D69: (F1) (D51+D62+D66)*D33
E69: (F1) (E51+E62+E66)*E33
F69: (F1) (F51+F62+F66)*F33
G69: (F1) (G51+G62+G66)*G33
H69: (F1) @SUM(D69..G69)
A70: '22. Depot to Port
D70: (F1) (D51+D62+D66)*D34
E70: (F1) (E51+E62+E66)*E34
F70: (F1) (F51+F62+F66)*F34
G70: (F1) (G51+G62+G66)*G34
H70: (F1) @SUM(D70..G70)
A71: '23. Depot to Salvage
D71: (F1) (D51+D62+D65)*D35
[illegible]
F71: (F1) ([illegible]51+F62+F6[illegible])*[illegible]
[illegible]
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H71: (F1) @SUM(D69..G71)
A73: '24. Theater Reserve to unit
D73: (F0) +D38
A75: 'DISPOSITION
A76: "-----------
A77: '1.  Abandoned
D77: (F1) +H44
H77: "FINAL
A78: '2.  K-Kill
D78: (F1) +H45
H78: 'DISPOSITN
A79: '3.  Battlefield Repair
D79: (F1) +H46
G79: "RETRO
H79: "(RUNNING
A80: '4.  Repair at Maint CP
D80: (F1) +H47
G80: "MOVEMENTS
H80: "TOTAL)
D81: (F1) "---------
G81: "(RUNNING
B82: 'TOTALS
D82: (F1) @SUM(D77..D80)
E82: (F1) +D82
G82: "TOTAL)
H82: (F1) +D82
A84: (F1) '5.  CP Transfer to ORG
D84: (F1) +H48
G84: (F1) +D84
A85: (F1) '6.  CP Evacution to DS
D85: (F1) +H49
G85: (F1) +D85+G84
A86: (F1) '7.  CP Evacution to GS
D86: (F1) +H50
G86: (F1) +D86+G85
A87: (F1) '8.  CP EVAC to Depot
D87: (F1) +H51
G87: (F1) +D87+G86
A88: (F1) '9.  CP to Salvage
D88: (F1) +H52
F88: "MULTIPLY
H88: (F1) +D88+D82
D89: (F1) "---------
E89: ' -------
F89: (F1) "HANDLED
B90: (F1) 'TOTALS
D90: (F1) @SUM(D84..D88)
E90: (F1) +D90
F90: "VEHICLES
E91: (F1) +E82+E90
F91: (F1) "(RUNNING
A92: (F1) '10. ORG Repair
D92: (F1) +D55+E55+F55+G55
[illegible]
H92: (F1) +H83+D92
A93: (F1) '11. Org EVAC to DS
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D93: (F1) '
F93: (F1) +H56
G93: (F1) +G87+F93
A94: (F1) '12. Org to Salvage
D94: (F1) +D57+E57+F57+G57
H94: (F1) +H92+D94
A96: (F1) '13. DS Repair
D96: (F1) +D59+E59+F59+G59
H96: (F1) +H94+D96
A97: (F1) '14. DS EVAC to Backup DS
F97: (F1) 0
G97: (F1) +G93+F97
A98: (F1) '15. DS EVAC to GS
F98: (F1) +H61
G98: (F1) +G97+F98
A99: (F1) '16. DS EVAC to Depot
F99: (F1) +H62
G99: (F1) +G98+F99
A100: (F1) '17. DS to Salvage
D100: (F1) +D63+E63+F63+G63
H100: (F1) +H96+D100
A102: (F1) '18. GS Repair
D102: (F1) +D65+E65+F65+G65
H102: (F1) +H100+D102
A103: (F1) '19. GS EVAC to Depot
D103: (F1) '
F103: (F1) +H66
G103: (F1) +G99+F103
A104: (F1) '20. GS to Salvage
D104: (F1) +D67+E67+F67+G67
H104: (F1) +H102+D104
A106: (F1) '21. Depot Repair
D106: (F1) +D69+E69+F69+G69
H106: (F1) +H104+D106
A107: (F1) '22. Depot to Port
D107: (F1) '
F107: (F1) +D70+E70+F70+G70
G107: (F1) +G103+F107
H107: (F1) +H106+F107
A108: (F1) '23. Depot to Salvage
D108: (F1) +D71+E71+F71+G71
H108: (F1) +H107+D108
D109: (F1) "---------
F109: (F1) '---------
B110: (F1) 'TOTALS
D110: (F1) @SUM(D106..D108)
F110: (F1) @SUM(F93..F107)
A112: (F1) '24. Theater Reserve to Unit
D112: (F0) +C40
G112: (F1) +G107+D112
C113: |::
A114: 'TRANSPORTATION DISTRIBUTION
A115: '-----------------------------
[illegible]
F116: 'LINE
[illegible]
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```
H116: "CODES
A117: '1.  Abandoned
E117: (PO) 0
F117: (PO) 0
G117: (PO) 0
A118: '2.  K-Kill
E118: (PO) 0
F118: (PO) 0
G118: (PO) 0
A119: '3.  Battlefield Repair
E119: (PO) 0
F119: (PO) 0
G119: (PO) 0
A120: '4.  Repair at Maint CP
E120: (PO) 0
F120: (PO) 0
G120: (PO) 0
A121: '5.  CP Transfer to ORG
E121: (PO) 1
F121: (PO) 0
G121: (PO) 0
H121: "D
A122: '6.  CP Evacution to DS
E122: (PO) 0.6
F122: (PO) 0.4
G122: (PO) 0
H122: "D
A123: '7.  CP Evacution to GS
E123: (PO) 0
F123: (PO) 0
G123: (PO) 0
A124: '8.  CP EVAC to Depot
E124: (PO) 0
F124: (PO) 0
G124: (PO) 0
A125: '9.  CP to Salvage
E125: (PO) 0
F125: (PO) 0
G125: (PO) 0
A127: '10. Organizational Repair
A128: '11. Org Evacuation to DS
E128: (PO) 1
F128: (PO) 0
G128: (PO) 0
H128: "D
A129: '12. Org to Salvage
E129: (PO) 0
F129: (PO) 0
G129: (PO) 0
A131: '13. DS Repair
E131: (PO) 0
F131: (PO) 0
G131: (PO) 0
[illegible]
A13[illegible] '14. DS EVAC to Backup [illegible]
[illegible] (PO) [illegible]
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F132: (PO) 0
G132: (PO) 0
A133: '15. DS Evacution to GS
E133: (PO) 1.05
F133: (PO) 0.3
G133: (PO) 0.7
A134: '16. DS Evacution to Depot
E134: (PO) 0.65
F134: (PO) 0.35
G134: (PO) 0.65
A135: '17. DS to Salvage
A137: '18. GS Repair
E137: (PO) 1.05
F137: (PO) 0.3
G137: (PO) 0.7
H137: "F
A138: '19. GS Evacution to Depot
E138: (PO) 1.2
F138: (PO) 0.2
G138: (PO) 0.8
A139: '20. GS to Salvage
A141: '21. Depot Repair
E141: (PO) 1.05
F141: (PO) 0.3
G141: (PO) 0.7
H141: "F
A142: '22. Depot to Port
E142: (PO) 1.2
F142: (PO) 0.2
G142: (PO) 0.8
A143: '23. Depot to Salvage
A145: '24. Theater Reserve to Unit
E145: (PO) 1
F145: (PO) 0
G145: (PO) 1
H145: "F
A147: 'TRANSPORTATION REQUIREMENTS
D147: "TOTAL
E147: "LCL
F147: "LINE
G147: "RAIL
H147: "CODES
A148: '---------------------------
A149: '1.  Abandoned
D149: (F1) +E149+F149
E149: (F1) +E117*D77
F149: (F1) +F117*D77
G149: (F1) +G117*D77
A150: '2.  K-Kill
D150: (F1) +E150+F150
E150: (F1) +E118*D78
F150: (F1) +F118*D78
G150: (F1) +G118*D78
[illegible]
[illegible]
[illegible]
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F151: (F1) +F119*D79
G151: (F1) +G119*D79
A152: '4.  Repair at Maint CP
D152: (F1) +E152+F152
E152: (F1) +E120*D80
F152: (F1) +F120*D80
G152: (F1) +G120*D80
A153: '5.  CP Transfer to ORG
D153: (F1) +E153+F153
E153: (F1) +E121*D84
F153: (F1) +F121*D84
G153: (F1) +G121*D84
H153: "D
A154: '6.  CP Evacution to DS
D154: (F1) +E154+F154
E154: (F1) +E122*D85
F154: (F1) +F122*D85
G154: (F1) +G122*D85
H154: "D
A155: '7.  CP Evacution to GS
D155: (F1) +E155+F155
E155: (F1) +E123*D86
F155: (F1) +F123*D86
G155: (F1) +G123*D86
A156: '8.  CP EVAC to Depot
D156: (F1) +F156+F156
E156: (F1) +E124*D87
F156: (F1) +F124*D87
G156: (F1) +G124*D87
A157: '9.  CP to Salvage
D157: (F1) +E157+F157
E157: (F1) +E125*D88
F157: (F1) +F125*D88
G157: (F1) +G125*D88
A159: '10. Organizational Repair
D159: (F1) +E159+F159
E159: (F1) +E127*D92
F159: (F1) +F127*D92
G159: (F1) +G127*D92
A160: '11. Org Evacuation to DS
D160: (F1) +E160+F160
E160: (F1) +E128*F93
F160: (F1) +F128*F93
G160: (F1) +G128*F93
H160: "D
A161: '12. Org to Salvage
D161: (F1) +E161+F161
E161: (F1) +E129*D94
F161: (F1) +F129*D94
G161: (F1) +G129*D94
A163: '13. DS Repair
D163: (F1) +E163+F163
E163: (F1) +E131*D96
[illegible]
G163: (F1) +G131*D96
[illegible]
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A164: '14. DS EVAC to Backup DS
D164: (F1) +E164+F164
E164: (F1) +E132*F97
F164: (F1) +F132*F97
G164: (F1) +G132*F97
A165: '15. DS Evacution to GS
D165: (F1) +E165+F165
E165: (F1) +E133*F98
F165: (F1) +F133*F98
G165: (F1) +G133*F98
A166: '16. DS Evacution to Depot
D166: (F1) +E166+F166
E166: (F1) +E134*F99
F166: (F1) +F134*F99
G166: (F1) +G134*F99
A167: '17. DS to Salvage
D167: (F1) +E167+F167
E167: (F1) +E135*D100
F167: (F1) +F135*D100
G167: (F1) +G135*D100
C168: |::
A169: '18. GS Repair
D169: (F1) +E169+F169
E169: (F1) +E137*D102
F169: (F1) +F137*D102
G169: (F1) +G137*D102
H169: "F
A170: '19. GS Evacution to Depot
D170: (F1) +E170+F170
E170: (F1) +E138*F103
F170: (F1) +F138*F103
G170: (F1) +G138*F103
A171: '20. GS to Salvage
D171: (F1) +E171+F171
E171: (F1) +E139*D104
F171: (F1) +F139*D104
G171: (F1) +G139*D104
A173: '21. Depot Repair
D173: (F1) +E173+F173
E173: (F1) +E141*D106
F173: (F1) +F141*D106
G173: (F1) +G141*D106
H173: "F
A174: '22. Depot to Port
D174: (F1) +E174+F174
E174: (F1) +E142*F107
F174: (F1) +F142*F107
G174: (F1) +G142*F107
A175: '23. Depot to Salvage
D175: (F1) +E175+F175
E175: (F1) +E143*D108
F175: (F1) +F143*D108
G175: (F1) +G143*D108
[illegible]
D177: (F1) +E177+F177
[illegible]
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F177: (F1) +C40*F145
G177: (F1) +C40*G145
H177: "F
D178: (F1) @SUM(D153..D177)
D180: (F1) "TOTAL
E180: (F1) "LCL
F180: (F1) "LINE
G180: (F1) "RAIL
A181: 'TOTAL HET RETROGRADE
D181: (F1) +E181+F181
E181: (F1) @SUM(E153..E156)+E160+E164+E165+E166+E170+E174
F181: (F1) @SUM(F153..F156)+F160+F164+F165+F166+F170+F171+F174+F175
G181: (F1) @SUM(G149..G175)
A182: 'TOTAL HET FORWARD
D182: (F1) +E182+F182
E182: (F1) +E163+E169+E173+E177+0.00001
F182: (F1) +F163+F169+F173+F177
G182: (F1) +G163+G169+G173+G177
A183: 'TOTAL LIFTS
D183: (F1) @SUM(E183..F183)+0.0001
E183: (F1) +E181+E182+0.000001
F183: (F1) +F181+F182
G183: (F1) +G181+G182
A185: 'LIFTS BY LR DESTINATION
D185: "TOTAL
E185: "LOCAL
F185: "LINE
G185: "HET COS
H185: "DIV
B186: 'LR 1 (DIV)
D186: (F1) +E186+F186+0.000001
E186: (F1) +E153+E154+E160
F186: (F1) +F153+F154+F160
G186: ((E186/72)+(F186/36))/4
H186: +G186
B187: 'LR 2 (CORPS)
D187: (F1) +E187+F187
E187: (F1) +D155+D164
F187: (F1) +E155+E164
G187: ((E187/72)+(F187/36))/4
B188: 'LR 3 (RCZ)
D188: (F1) +E188+F188
E188: (F1) +E156+E165
F188: (F1) +F156+F165
G188: ((E188/72)+(F188/36))/4
H188: "CORPS/TH
B189: 'LR 4 (COMMZ)
D189: (F1) +E189+F189
E189: (F1) +E166+E169+E170+E173+E174+E177
F189: (F1) +F166+F169+F170+F173+F174+F177
G189: ((E189/72)+(F189/36))/4
H189: @SUM(G187..G189)
[illegible] 'TOTAL CORPS/T[illegible]
[illegible]
[illegible] (F1) @SUM(E187..E189)
[illegible]
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C191: 'TOTAL
E191: (F1) @SUM(E186..E189)
F191: (F1) @SUM(F186..F189)
G191: @SUM(G186..G189)
F192: (F1) +E191+F191
A193: 'POSSIBLE BACKHAULS
A194: '-----------------
D195: "LOCAL
E195: "LOCAL
F195: "LINE
G195: "LINE
A196: 'DS TO GS
C196: '#15
D196: +E165*(0.7/1.05)
E196: +E165*0.35/1.05
G196: +F165
H196: "LOCAL
A197: 'DS TO DEPOT
C197: '#16
D197: +E166
F197: +F166
H197: +D208
D198: '--------
H198: +E208
D199: +D196+D197
H199: "------
H200: @SUM(H197..H198)
A201: 'GS TO DSA
C201: '#18
D201: +E169*0.7/1.05
E201: +E169*0.35/1.05
G201: +F169
A202: 'GS EVAC TO DEPOT
C202: '#19
E202: +E170*0.2/1.2
A203: 'DEPOT TO DSA
C203: '#21
D203: +E173*0.7/1.05
E203: '--------
F203: +F173
H203: "LINE
A204: 'TR TO DSA
C204: '#24
D204: +E177
E204: @SUM(E201..E202)
H204: +F208
D205: '--------
E205: +E196
H205: +G208
C206: +D199
D206: @SUM(D201..D204)
H206: "------
H207: +H204+H205
A208: 'SMALLER OF VALUES ABOVE
D208: @MIN(C206..D206)
E208: @MIN(E204..E205)
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F208: @MIN(F197..F203)
G208: @MIN(G196..G201)
A210: 'TOTAL REDUCTIONS (ALL CORPS/THEATER)
E210: +H200
G210: +H207
A212: 'RESULTS
A213: '-------
A215: 'RETROGRADE LIFTS IN THE DIVISION AREA
G215: +D153+D154+D160
A217: 'RETROGRADE LIFTS IN THE CORPS/THEATER AREA
G217: +D164+D165+D166+D170+D174
A219: 'PERCENT LOCAL HAUL IN DIVISION
G219: (P1) +E186/D186
A221: 'PERCENT LOCAL HAULS IN CORPS/THEATER AREA
G221: (P1) +E190/D190
F223: 'TOTAL LIFTS
A224: '# HET COS TO SUPPORT INDIVIDUAL MISSIONS =
F224: '-----------   =
H224: (F2) ((E183/72)+(F183/36))/4
F225: "4 DAYS
F227: 'TOTAL - BACKHAULS
A228: 'INTEGRATING INDIVIDUAL MISSIONS
E228: ^=
F228: '-----------------  =
H228: (F2) (((E183/72)+(F183/36))-((E210/72)+(G210/36)))/4
F229: "4
G229: 'DAYS
F231: 'HET RETRO
A232: 'TOTAL LIFTS FOR RETROGRADE ONLY
E232: ^=
F232: '--------------
G232: '     =
H232: (F2) ((E181/72)+(F181/36))/4
F233: "4 DAYS
F235: 'RETRO + FORWARD
A236: '"F" DONE BY RETROGRADE BACKHAULS
E236: '     =
F236: '  MINUS
G236: '     =
H236: +H228-H232
F237: "RETRO ONLY
A239: 'Truck cos for Total "F"/4 days
F239: ((E182/72)+(F182/36))/4
A241: '# OF 3 POINT BACKHAULS - CORPS/THEATER
F241: +D208+E208+G208
```

APPENDIX G

UNIT MOVES

G-1. INTRODUCTION. This appendix describes the method used to determine the amount of transportation resources required to perform the task of moving units on the battlefield. The method uses AFPDA and CAA models, as well as independent factors that allow realistic results.

G-2. METHODOLGY. The methodology to derive transportation resource requirements for unit moves is depicted in Figure G-1.

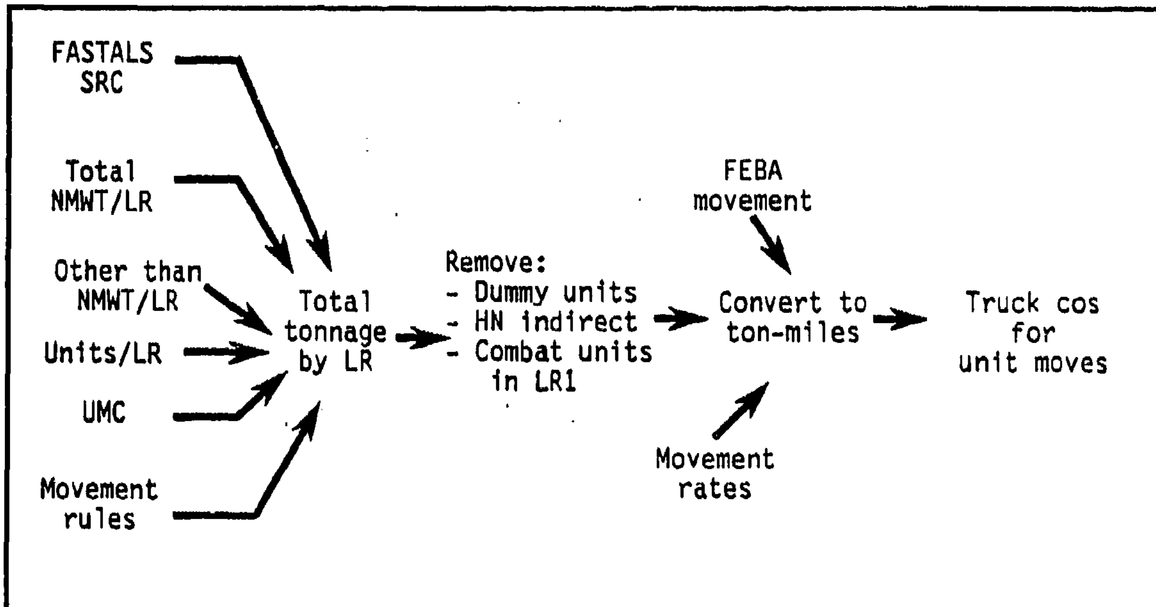

Figure G-1. Unit Move Methodology Schematic

a. The results of the FASTALS model for the PFCAE-96 and the PFASS scenarios provide the SRC for each type of unit, the number of units in each LR, and the NMWT for each SRC.

(1) NMWT is defined as that portion of the TOE that can be moved in a one time lift using the unit's wheeled vehicles fully loaded with the unit's TOE equipment. The NMWT figures are provided by the Military Traffic Management Command - Transportaton Engineering Agency (MTMC-TEA).

(2) In addition to the weight accrued using the standard definition, a factor of 232.05 pounds per soldier is added to the calculation for each unit SRC tonnage. This figure is included to account for some supplies that will accompany the troops during the deployment and is derived from AFPDA.

b. "Other than NMWT" is a correcting factor added to all SRCs that attempts to include a tonnage figure for unit equipment and supplies not included in the TOE and damaged items that will be acquired by the SRC unit during the course of war. For example, all units carry a basic load of ammunition, rations, and medical supplies as a reserve to use in the event that the normal supply channel is interrupted. A unit move on the battlefield will include moving the basic load as well as some amount of supplies routinely issued. The Other than NMWT correcting factor is estimated as 428 pounds per soldier for division units and 623 pounds per soldier for all units in the corps, RCZ, and COMMZ. A more detailed explanation of this factor is found in Chapter 2, paragraph 2-13. The total NMWT and Other than NMWT is compiled and formed into truck companies equated with FASTALS Workload 18, 1,000 short ton hours of dry cargo and unit equipment by truck per day (see Chapter 3, paragraph 3-13).

c. The Combined Arms Activity at Fort Leavenworth provided CAA with the current Manpower Requirements Criteria for all Army units. Included in the MARC header data is the UMC which is an estimate of the frequency of move on the battlefield for each unit (Table G-1). All units found in the PFCAE-96 and PFASS scenarios were paired with a UMC either by a computer match using the SRC or were manually paired with the code for a similar unit found in the Fort Leavenworth data. The units were then processed through a program that distributed the movements over time based on the UMC. Each move identified with a FASTALS 10-day TP. Units with a UMC of A or B could be moved more than once in a single TP; others with UMCs of C, D, or E having values greater than 10 will move during some TPs and not others. By multiplying the NMWT for each unit in the LR by the UMC for the particular TP, the total potential tonnage for each unit move can be determined in each 10-day time period.

Table G-1. Unit Movement Codes

UMC	MARC Value	ETRANS Value
A	Once in 3 days or less	3 days
B	Once every 4 to 7 days	6 days
C	Once every 8 to 17 days	13 days
D	Once every 18 to 39 days	29 days
E	Less than once every 40 days or more	50 days

d. A specific unit can be employed by only one of three alternatives: it is forward-stationed in Germany ready to fight at D-day, it arrives in Europe prior to D-day but is employed after D-day, or it deploys to Europe and is employed after D-day. Figure G-2 illustrates the simplified algorithm developed to differentiate among the three possibilities. The movement to

the initial combat location is programmed by USAREUR and not further considered in ETRANS. (Also not considered is the possibility that a unit could move rearward from the APOD to arrive at its wartime location.) The first time a unit is eligible for a unit move is after it has been in its wartime position for that length of time stipulated by the UMC (i.e., 6 days for a unit with a UMC of B).

```
                                   D-day
                                     |
                                     |      Move        Move       Move
Forward-stationed    |--Deploy--|--Combat--|----------|---------|--->
  units                              |
                                     |           Move        Move        Move
Pre-D-day arrival:        |--Deploy--|--Combat--|----------|----------|->
  post-D-day employment              |
                                     |                            Move
Post-D-day arrival                   |       |--Deploy--|--Combat--|------>
                                     |
```

Figure G-2. Eligibility for Unit Move

G-3. WORKLOAD 18

a. FASTALS output displays all generic units used as workload counters as well as all host nation direct and indirect contributions. Except for host nation direct units which are supported by the US, all generic units must be deleted from the list of units needing support for unit moves. Since FASTALS displays Workload 18 in units of 1,000 short ton-hours per day, the NMWT accrued by time periods is converted to ton-hours by using the formula in Figure G-3.

```
                         / --- LR 2 = 8.45 miles/day (100% of FEBA movement)
                        / ---- LR 3 = 5.63 miles/day (67% of FEBA movement)
                       / ----- LR 4 = 4.22 miles/day (50% of FEBA movement)
                     6DT
       Workload = -------
                     5RL
                        \------- 10 MPH local haul (all UMC A moves)
                         \------ 12 MPH corps (all UMC B,C,D,E moves in LR 2)
                          \----- 24 MPH RCZ (all UMC B,C,D,E moves in LR 3)
                           \---- 26 MPH COMMZ (all UMC B,C,D,E moves in LR 4)

            WHERE: D = round trip distance in miles
                   T = short tons hauled (NMWT)
                   RL = rate of travel in MPH from origin LR
                   6/5 = adjusting factor for loading/unloading of vehicles
```

Figure G-3. Computation of Workload 18

b. Also shown in Figure G-3 are the values used to adjust the formula to compensate for LR characteristics. The rates of travel (RL) are provided in AFPDA. The distance is an average value derived from FASTALS expressed as "kilometer change in mean FEBA" each day for the 90-day scenario. Reducing the daily round trip distance by 33 percent for LR3 and 50 percent for LR4 compensates for the supposition that moves for units originally located 200-500 km rear of the corps are not necessarily required to be relocated the same distance to the rear of the corps as the battle progresses.

G-4. RESULTS

a. The concept of the analysis and the computer program formulation will yield conservative results. Only unit moves required as a direct result of an adversely moving FEBA are calculated. Units moving for other than withdrawal purposes are not included.

b. The results are an estimate based on the one figure, nonmobile weight, which is well-developed by TRADOC. There are many additional items that move with a unit in the field in addition to NMWT. Table 2-13 lists several other categories of property that would add to the amount of weight to be moved. Additionally, several situational factors are provided in paragraph 2-9. Paragraph 2-9b(5) lists several factors that may decrease the NMWT results. The net result of increases and decreases to NMWT caused by the many factors to consider is difficult to estimate, but it appears most likely that unit weight would increase significantly.

APPENDIX H

FASTALS OVERVIEW

H-1. MODEL DESCRIPTION. The purpose of the Force Analysis Simulation of Theater Administrative and Logistic Support (FASTALS) Model is to compute administrative and logistical workloads and to generate the theater-level support force structure necessary to round out a combat force in a postulated confrontation. FASTALS, a requirement model, may be used in any force planning simulation to develop a force that is balanced, time-phased, and geographically distributed. A trooplist is said to be balanced when the individual units comprising the list are capable of accomplishing the various workloads generated by the total force. Trooplists are said to be time-phased when unit requirements are prescribed for each time period in the simulation. The major elements of support are maintenance, construction, supply, transportation, hospitalization and evacuation, and personnel replacement. Major DA studies utilizing FASTALS include the Total Army Analysis (TAA), OMNIBUS, and the Joint Strategic Planning Document Analysis (JSPDA). The model is also used in excursions to assess the impact of force modernization, logistic initiatives, and host nation support contributions on US force structure requirements.

H-2. INPUTS. The FASTALS Model depends on the results of a combat simulation (PFCAE-96 and PFASS) to obtain a starting point for the rounding out of logistic support requirements. Each study has its own set of data files for each theater examined. The data must reflect the force being portrayed on the force tape, which has been prepared by the study proponent. The two major input files are described.

a. MASTERFILE (MF). This file contains data necessary to allocate units and to prescribe unit support requirements. Key entries include:

- **Logical Region (LR).** Reflects a unit's normal area of operation in the theater (1-division, 2-corps, 3-rear combat zone, 4-COMMZ, 5-ports, 6-offshore). LRs are further delineated into three sectors which divide the LRs into horizontal borders. For example, in NATO the three sectors generally represent NORTHAG (sector 1) and CENTAG (sectors 2 and 3).

- **Manpower Requirement Criteria (MACRIT) Data.** Represent daily manhours of automotive (DS, GS), power generation, aircraft, and other types of maintenance needed to maintain the equipment in each unit, and which is *above* the unit's organic capability to perform.

- **Allocation Rules (AR).** The most critical of all MF data. An AR is a statement of a unit's capability, mission, and/or doctrinal employment and, in conjunction with other data, determines how many of a certain type unit will be reflected in the final trooplist of requirements. All ruled are coordinated with the study sponsor and the TRADOC community. Three types of AR exist:

(1) Manual Entry. Units are placed directly into the scenario by time period and location. Almost all combat units are entered manually, as are a limited number of CS/CSS units that have a special mission or fixed quantity (i.e., petroleum pipeline companies that operate emergency pipelines in accordance with certain contingency plans).

(2) Existence Rule. Units are allocated based on the existence of some other units(s) in the theater. This allows the theater to be rounded out in accordance with normal TOE doctrine.

(3) Workload Rule. Units are allocated based on the capability to accomplish generated workloads.

(4) Other Data. The MF also includes standard requirement codes, unit descriptions, strengths, and weights of the units.

b. Scenario. This data set represents the major variable inputs which, when combined with the MF, generates the statement of support force requirements.

- Combat simulation Data. The combat data required to run FASTALS include unit location and employment time, level of combat intensity, ammunition consumption, damaged and repairable tanks/APCs, casualties, and changes in FEBA.

- Other data provided include a layout of the theater's geographical structure; number of forward deployed and POMCUS units; PWRMS, stockage policy, and supply data; engineer construction policy; and transportation data representing links, paths, and capacities for each mode (highway, railroad, waterway, pipeline).

H-3. EXECUTION. First, the combat units employed by the combat model are augmented by direct input units and by units that are implied by the organizational structure of the theater being analyzed (e.g., number of corps). Next, units that are required on the basis of the existence of other units in the theater are added to the list. The model then computes workloads generated by these units in terms of personnel replacements, hospital admissions, supplies, maintenance, construction, and transportation. These workloads are then used as a basis for adding units such as hospitals and medium truck companies. This new set of units generates another increment, and so the cycling process begins. Additional units increase the workloads which, in turn, generate a requirement for more units. This cyclic process, steps 5 through 13 in Figure H-1, continues until the model computes the same set of units (trooplist) that was computed on the previous cycle (requirements converge).

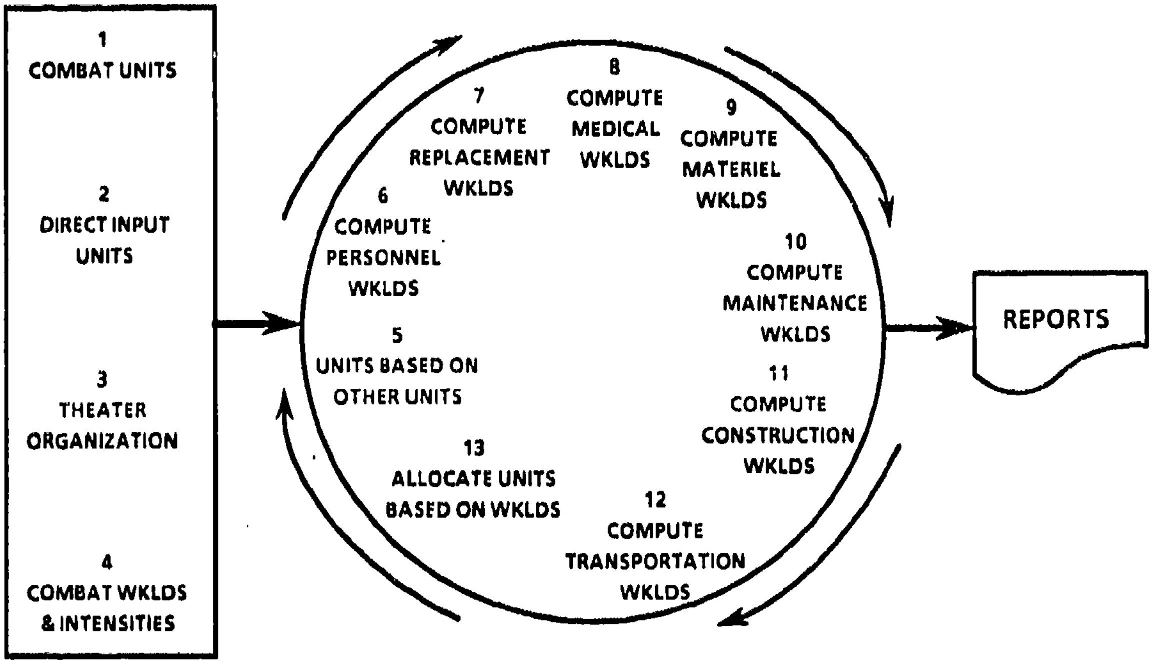

Figure H-1. FASTALS Logic Flow

H-4. OUTPUTS. The principal output produced is the time-phased troop deployment list of theater requirements. Other reports provide consumption and stockage requirements for each category of supply. Additional reports include 48 workload summaries that relate to personnel replacements, medical, materiel, maintenance, construction, transportation, and casualties.

H-5. WORKLOADS. Table H-1 lists the titles of all the workloads. Those workloads with asterisks directly influence the study.

a. Workload 1, US Army Population in Thousands, is the total Army population that is functioning in the specific physical or logical region. No differentiation is made by unit, task, or mission. For some analyses, only division personnel in LR1 are used as a basis. When this occurs, Workload 22, US Army Nondivisional Population in Thousands, is subtracted from Workload 1 to obtain only that population directly associated with a division. Workload 19, 1,000 Replacements through Replacement Camps/Day, is another personnel-oriented workload that was used to compare incoming theater transportation requirements with the exodus of NEO participants.

b. Workload 14, 1,000 Hospital Patients in Theater, was used to support the Patient Flow Model that tabulated the patients needing transportation between hospitals.

c. Workload 15, 1,000 Enemy Prisoners of War, provided the data that was used to analyze the transportation requirements for prisoners. Enemy prisoners are captured in LR1 only and are a function of US Army population.

Table H-1. FASTALS Workloads

Workload number	Title
1*	US Army population in thousands
2	1,000 STON dry cargo/Unit equip seaports/day
3	1,000 Manhours engineer const/day
4	1,000 Manhours nondiv DS auto maint/day
5	1,000 Manhours of general spt automotive maint/day
6	1,000 STON-day cargo/unit equip through afld/day
7	1,000 STON Class 5 stock change/day
8*	1,000 STON ALOC Class 9 issue/day
9	1,000 STON hours BULK POL moved by truck/day
10	1,000 Manhours power generation equipment maintenance per day
11	1,000 STON dry cargo (less Class 5 and Class 8) stored
12	1,000 Manhours DS nondiv track vehicle repair/day
13	1,000 Manhours nondiv avn inter maint (AVIM)/day
14*	1,000 Hospital patients in theater (CZ or COMMZ)
15*	1,000 Enemy POW
16*	1,000 STON Class 5 consumed/day
17	1,000 STON bulk Class 3 stored
18*	*1,000 STON hrs dry cargo and unit equip/truck/day
19*	1,000 Replmts through replacement camps/day
20	1,000 STON dry cargo transshipped/day
21	1,000 STON bulk Class 3 issued/day
22*	US Army nondiv population in thousands
23	1,000 STON general supplies issued/day
24	1,000 STON Class 5 stored
25	1,000 STON general supplies stock change/day
26	1,000 STON dry cargo and unit equip/inland waterway/day
27*	1,000 STON Classes 1 and 6 consumed daily
28	1,000 STON unit equip disch at ports/day
29	1,000 Manhours of divisional DS combat damage repair/day
30	1,000 Miles highway MSR LOC used
31	1,000 Manhours GS combat damage repair/day
32	1,000 Manhours GS FC instrument maint/day
33	1,000 Manhours GS radar maint/day
34	1,000 Manhours artillery armament maint/day
35	1,000 Manhours FC system maint/day
36	1,000 Manhours DS nondiv gas turb eng maint/day
37	1,000 Manhours GS COMSEC equip maint/day
38	1,000 Manhours GS COMMEL equip maint/day
39	1,000 Manhours SIGINT/EW maint/day
40	1,000 Manhours GS turbine eng maint/day
41*	1,000 STON Class 2 supplies consumed/day
42*	1,000 STON Class 3 (pkg) consumed/day
43	1,000 STON airdrop resupply/day
44*	1,000 STON Class 7 issued/day
45*	1,000 STON Class 8 consumed/day
46*	1,000 STON Class 9 (non-ALOC) issued/day
47	1,000 STON water consumed/day
48	1,000 STON DS COMMEL equip maint/day

d. Workload 18, 1,000 STON-hours Dry Cargo and Unit Equipment/Truck/Day, is the tabulation of the highway portion of total theater transportation requirements. Other transportation workloads are concerned with movement by air, waterway, and pipeline or through airports and seaports. Calculation of medium truck force structure is a direct result of Workload 18 accumulations.

e. Workloads 8, 27, 41, 42, 44, 45, and 46 are all concerned with the positioning and consumption of one or more classes of supply. Changes in the supply policy and location in the physical and logical regions provided one of the significant differences between PFCAE-96 and PFASS.

H-6. BOUNDARIES. Theater boundaries, particularly logical regions, have been referenced at length in this study. The following discussion orients the reader on how the FASTALS program segments the battlefield.

a. Determining the Sector Boundaries

(1) The decisions facing the user when setting up the sector in a theater are: (1) how many sectors to use; and (2) how to select the sector boundaries. Addressing the first decision, there exists an absolute upper bound of five sectors that may be used with the model in its present state. Thus, one, two, three, four, or five sectors may be played. As in the case of theater map construction, sector boundaries, when selected, are usually held constant for a number of studies.

(2) A sector should represent an independent axis of logistic activity. The user has the choice of selecting sectors that correspond exactly to the corps boundary for the tactical situation being represented, or of choosing sectors that represent an axis of the particular activity in which he is interested. For example, the tactical situation may involve five different corps at a particular point in the analysis. In contrast, the FASTALS user who may have the logistics of the operation as his primary interest recognizes that the logistic dynamics of the theater could be satisfactorily represented by using only two sectors. In any case, there should always be an understanding between the user of the FASTALS Model and the user of the combat model as to which sectors each is using. This ensures that interchange of information on movements is feasible.

(3) Sector FEBAs will advance or recede over the period of time that is simulated by FASTALS. Since the entire forward boundary of the sector moves as a unit in response to changes in the FEBA, the user must make sure that the sectors he specifies will allow the resolution of FEBA movement that he desires.

(4) In the notional example in Figure H-2, the map shows three sectors. In the upper chart the FEBA is plotted along the sector boundaries and illustrates the position of the theater forces in time period 1 (TP1). In the lower chart, the FEBA again is plotted and shows a new position of the forward edge of each sector in the theater in TP2. Since only three sectors are shown, the resolution in each representation of the FEBA is limited by the width of the chosen sectors.

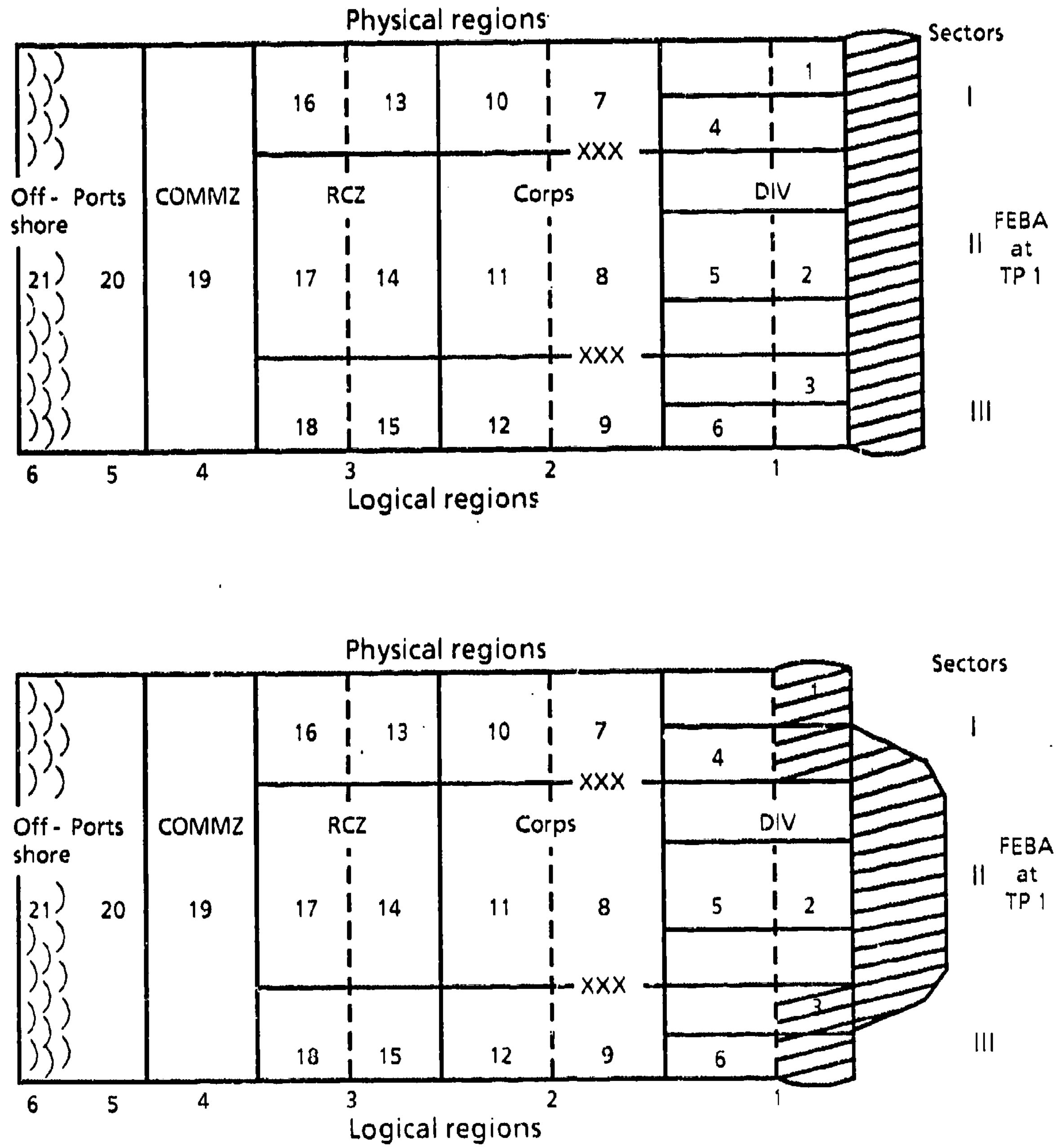

Figure H-2. Notional Theater FEBA Movement

(5) It should be noted that since sectors are considered independent axes of activity, they are treated separately in the allocation of combat service support units. This means that a unit assigned to one sector may not use its excess capabilities to fulfill the requirements in another independent sector. It then becomes clear that areas which can be supported by a single force should be designated as one unique sector.

(6) A user may consider certain sectors to be independent near the forward edge of a theater but joined at the rear. This situation can be handled by the assignment of "common regions" which will be discussed later. In the preliminary stages the user should specify all sectors as if they will retain independent axes of activity.

(7) Finally, as the number of sectors increases, the number of regions required for adequate resolution of the FEBA movement also increases. Since the present limit on the number of possible regions is 53, the user must decide how to trade off the lateral resolution of FEBA movements (which improves with the number of sectors used) with the longitudinal FEBA resolution (which increases with the number of regions per sector). The computer running time of the model is a function of the number of sectors chosen, thus the judicious selection of the proper set of sectors will give a balance between resolution and running time. When all the preceding points have been considered, the user should take the theater outline and draw in the selected sectors.

b. Specifying the Physical Region Boundaries. Once an acceptable subdivision of the theater into independent sectors has been made, the user must then segment the various sectors into areas called physical regions. The physical regions serve as reference points in determining the effects of operational activities that are a function of location or movement. In Figure H-2, the three-sector theater has been divided into 21 physical regions. The model provides extreme flexibility in defining physical regions. The planner may specify as many regions to a sector as he deems necessary as long as the total number of regions does not exceed 53. The decision regarding the placement of regional boundaries is affected primarily by two considerations:

(1) Physical regions are either entirely under the determination of friendly forces or entirely under the determination of the foe. The positioning of a FEBA in the middle of a physical region is not possible in the FASTALS simulation. Thus, the physical region into which the FEBA moves is either considered unharmed and playable or completely lost. There is no FEBA movement until the support units are forced to relocate. For example, Figure 3-1 shows the FEBA in Sector III at the forward edge of physical region 3. Figure 3-1 also shows the FEBA at the base of physical region 3. These two positions represent the extent to which the FEBA movement can be represented in Sector III as it moves rearward from its initial position. Thus, the "depth" of region 3 determines the resolution of the FEBA movement in the forward section of Sector III. This consideration should cause the user to determine accurately the resolution of FEBA movement he required in order to reflect the level of detail in which he is interested. Generally, the depth considered adequate for a region is that distance required to accommodate an element of the Army organizational structure such as division or corps and its support units. The regions are usually centered around main supply points; thus, when the supply point is lost, the entire region can be considered unusable for friendly forces.

(2) The FASTALS Model simulates the transportation activity in the theater by tracking interregional movements of men and supplies. It does not directly address the activity of intraregional transportation. The transportation network needed for any particular theater is determined by the number of independent regions being played. The network developed must specify transport paths into each region to satisfy its requirement for all types of commodities. This consideration requires the user to make a good judgment as to how complex a transportation network he is willing to designate for the level of transportation detail he desires.

(3) Taken together, the two considerations indicate that with a greater number of regions one obtains more FEBA movement resolution and finer transportation detail. These desirable features of a large number of regions are counterbalanced by the increased amount of input data needed for the theater transportation network, FEBA movements table, prepositioned equipment specification, increased run time, and others.

(4) A final choice that the user must make is which physical regions, if any, he will want to be common. In Figure H-2, physical regions 19 through 21 are common because they are at the rear of Sectors I, II, and III in their breadth. The common physical regions serve to merge the three sectors which are independent at forward points into one area common to both sectors. Therefore, units allocated to regions 19 through 21 can support units in both Sectors I, II, and III. Common physical region 21 represents a common offshore area which supports the entire theater (i.e., all sectors). The common physical regions thus give the user the ability to choose a geographical point at which he desires to treat two or more independent sectors as one common area. The only restriction is that once a number of sectors have been merged into a common region, they may not again become independent in an area to the rear of the specified common region. The common region is used most frequently to denote areas that serve as COMMZ or offshore echelons.

(5) When the planner has made the decision on how to segment the sectors into physical regions, he should sketch in the regions on his theater map and give each one a unique number. Having done this, the user has the information to input on the physical regions in each sector and the number of sectors common to each region. A limitation of the model is that all six logical regions must be represented, notwithstanding the results of the warfight. Therefore, in the case of the theater map shown in Figure H-2, only physical regions 1 through 9 may be lost.

c. **Specifying the Logical Region Boundaries.** When the planner has finished partitioning the theater into sectors and physical regions, data should be prepared to provide the model with a time-varying organizational picture of the operation to be simulated. Creating this input is accomplished in two steps:

- A planner inspects a time period by time period report of FEBA movement which is obtained from the combat simulation.

- The planner distributes the various echelons of the Army organization throughout the sectors of the theater.

Figure H-2 shows the FEBA plots for a sample theater for two successive time periods.

(1) The planner will find it helpful if a theater outline of the type shown for each time period to be played in the exercise is constructed. These outlines will serve as worksheets for plotting the changing FEBA and arranging the Army echelons in the sectors. Upon completion of the set of outlines to the level of detail shown in Figure H-2 for each time period to be simulated, all of the information needed for creating the model input that relates to organizational configuration will be available for use by the planner.

(2) In arranging the Army echelons in the various sectors, the following guidelines should be observed:

(a) A common physical region must contain the same logical regions in every sector of its span. For example, in Figure H-2, region 19, which is to the rear of Sectors I, II, and III, contains the COMMZ echelons for Sectors I, II, and III. The model does not accept a situation where region 19 contains different echelons in Sector I than it does in Sector II.

(b) A given echelon may span more than one physical region. It is possible for the division echelon shown in Figure H-2 to span regions 1 and 4.

(c) No more than one echelon may reside in a single physical region.

(d) Transport workloads relating to nonmobile unit equipment movements are computed to the forwardmost physical region contained in a logical region. Having completed the creation of the theater organization maps for all time periods, the user is ready to specify the input which correlates the logical and physical regions.

H-7. THE TRANSPORTATION ALGORITHM

a. Introduction. Transportation is probably the most critical area of FASTALS to be considered. This is due to the number of workloads to which it contributes, the number of units that are allocated based on transportation workloads, and the amount of input required to exercise the algorithm. In this section, it is assumed that the reader is familiar with the basic concepts of theater organization, sectors, and the distinction between logical and physical regions. Before proceeding, some definitions are given:

(1) Link. A notional representation of a connection between two points on a map. The connection is assumed to be of a single mode of transport.

(2) Mode. A type of transportation function simulated in the model. The modes presently considered are shown in Table H-2.

(3) Cargo. An aggregation of one or more classes of supply that are treated identically with respect to their distribution to modes, preference of modes, and priority.

(4) **Path.** A series of links that originate at the origin of the first link and terminate at the terminus of the last link. In the case of a single link path, link and path are synonymous. A given path may consist of links of various modes of transport, but for the purpose of the simulation, each path is assigned a unique mode. Usually, the mode to be assigned to a path should be the mode that dominates the path in terms of distance, but where modes 3 or 7 are included in a path, the mode of the path should be 3 or 7. The major consideration in constructing the transportation network is the path's region of destination. In fact, it is this consideration that drives the planner to create paths, since each physical region must have at least two paths that terminate in it.

(5) **Transshipped.** The transfer of cargo from one mode to another for reshipment. This mission is accomplished by the Transportation Cargo Transfer Company. Workload 20 in FASTALS computes the dry cargo transferred from rail and air terminals to trucks per day. Program FAS provides the STONs that are transshipped by time periods.

(6) **STON-hours.** A computation of additional time for loading and unloading to better represent mission trip time which considers round trip time, rate of movement and STON hauled. The formula used by FASTALS is found in paragraph H-7d.

Table H-2. FASTALS Transportation Modes

Mode	Meaning
1	Railroad
2	Highway
3	Pipeline
4	Intertheater airport
5[a]	Seaport
6	Waterway
7	POL port
8	Intratheater airport/airway
9[a]	LOTS/beach or inland waterway port
10[a]	Unit equipment movement

[a]Care must be exercised in using mode 5 because workload 2 will accumulate any tonnage passed through a mode 5 link. Mode 9 can be used to represent either inland waterway or LOTS/beach operations. A code of "0" is used primarily in denoting the mode of a path rather than a link. When the path is indicated to be of mode "0", the model may use it for resupply movements but will never give credit to a workload.

b. Structuring the Network

(1) Figure H-3 is the initial representation of a theater of operations that is to have a network structure for it. The numbers at the top right of each compartment have been assigned arbitrarily to the physical regions of the theater. Numbers to be associated with links are adjacent to the links they represent. The links shown are described in Table H-3.

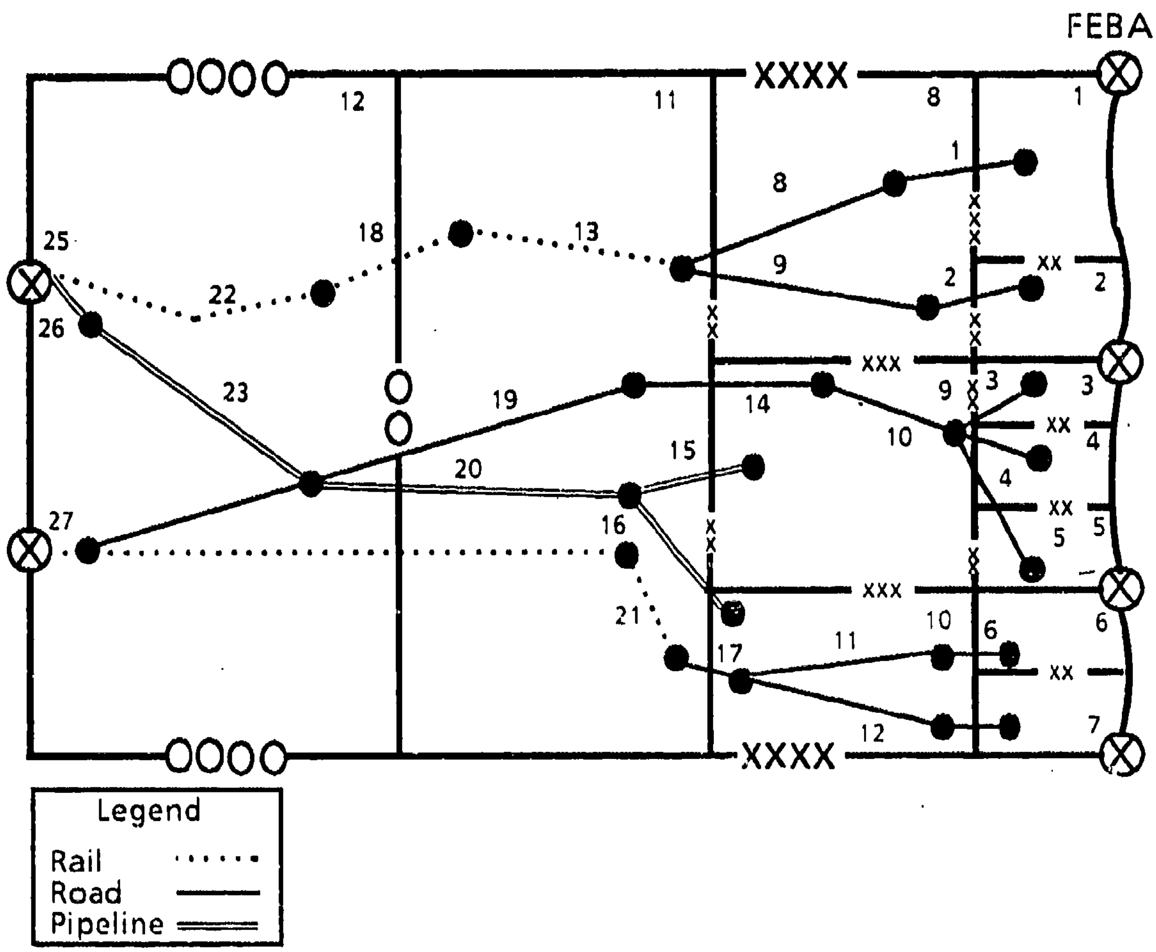

Figure H-3. Transportation Network

Table H-3. Transportation Network Development

Link number	Origin region of link	Mode of link
1	8	Road
2	8	Road
3	9	Road
4	9	Road
5	9	Road
6	10	Road
7	10	Road
8	11	Road
9	11	Road
10	9	Road
11	10	Road
12	10	Road
13	11	Rail
14	11	Road
15	11	Pipe
16	11	Pipe
17	11	Road
18	12	Rail
19	12	Road
20	12	Pipe
21	12	Rail
22	12	Rail
23	12	Pipe
24	12	Rail
25	12	Seaport
26	12	POL port
27	12	Seaport

(2) Step 1 of the network structuring was taken in response to the question of "How are region 1's requirements for resupply to be satisfied?" The answer was: "The requirement can only be met by highway transport from region 8." With this in mind, link number 1 will be designated as a path into region 1.

(3) Similar questions produce links to all other regions except that in this case, region 9 can be resupplied with POL through an existing pipeline (link 15) as well as by highway (link 14). At this point the planner must make a critical decision with respect to region support. For example, if links 2 and 9 are designated as a two-link path which satisfies region 2's requirements, then the model will pass region 2's requirement back to region 11. On the other hand, if a four-link path (link 2, 9, 13 and 18) is specified for support of region 2's requirement, then the region's requirement is passed back to region 12.

(4) The planner should attempt to construct a network of links which include links originating in the destination physical region. Since workload is accumulated in the origin region, a network of single links into the forwardmost physical regions would show no workload in the division area.

(5) Each physical region must have at least one unit deployment path beginning at a theater debarkation port and terminating at the region. A unit movement path is distinguished from a resupply path by its designation as mode "0". Thus, a region's resupply is drawn over paths from adjacent regions, whereas unit deployments are drawn directly through the ports. Use of deployment paths for resupply of a given region would cause the routine to bypass intermediate regions having stocks which are intended for the support of the given region.

(6) Once the preceding logic is understood by the planner, the structure of the network should fall into place by reapplying the basic question of "How is a region to be supported" to each of the regions in each sector, starting with the forwardmost region and working back to the base region. Having made a first pass at the structure, the planner can now specifically define the paths that he has kept in mind in the course of the link definition. These paths will include the above mentioned unit deployment paths. For example, a path consisting of links 25, 22, 18, 13, 8, and 1 could be specified as mode 0 to account for deployments into region 1.

(7) The path data does not necessarily have to assume an origin in an adjacent region. Paths may originate in any region if the intent is to reflect a throughput policy. The planner should be aware, however, that bypassing one or more regions may ignore available stocks and cause an irregular distribution pattern.

c. Algorithm

(1) Before proceeding with the discussion of the transportation algorithm the reader should review the input sheets that contain the data require to drive the model.

(2) The basic guides that are passed to the Transportation Model are the requirements for up to 12 classes of supply in each region for each simulated time period. These requirements are computed as a three-step process by the Materiel Model. The process is:

(a) Step 1: Compute the daily consumption of each class in each region for all time periods.

(b) Step 2: Apply stated stockage-objective policies for each class in each time period to obtain gross requirements of materiel.

(c) Step 3: Compute the differences of gross requirements between successive time periods to obtain net resupply requirements of each category in each region for all time periods. A negative requirement is interpreted as an excess in a given region during the time period in which it occurs. The Transportation Model will utilize this excess if a region that is forward

of the overstocked region has a positive requirement and path data has been drawn to allow the movement from the overstocked region.

(3) The Transportation Model is exercised independently for each time period of the game. For each time period, the procedure is as follows:

(a) Step 1: Distribute each region's net movement requirements of resupply of up to 12 classes into 25 mode-category groups (also called mode-classes). For example, Class I subsistence can be distributed into three mode-categories: namely, subsistence/highway, subsistence/railway, and subsistence/air. The distribution parameters are given by input Sequence 24. The resulting net requirements of the 25 mode-categories constitute an ideal situation that can only occur when there are available capacities for each mode of transport into each region and path data exists for each mode into each region. Departures from the given distribution will take place when a mode of transportation into a region has been saturated, or perhaps does not even exist.

(b) Step 2: Starting with the most forward physical region of sector 1, the model seeks a means of satisfying requirements of each of the 25 category modes. The method of choosing is best shown by an example.

1. Assume that the candidate paths for satisfying all requirements of region 7 are as given below:

Path #	Mode of path	Links in path
7	3	4
8	2	5,8
9	1	6

2. The transportation logic is incorporated as multiple scenario inputs which must be combined in some consistent manner.. Those inputs are described below.

3. Sequence 24A allows the planner to identify the FASTALS category of supply to which the remaining logic sequences apply.

4. The 12 categories of supply are combined with modes of transport, and the combination is referred to as a mode-category, i.e., ammunition-highway. There are 25 possible mode-categories.

5. Sequence 24B tells the model which mode-category should be satisfied first and then subsequently through the 25th. The logic used in assigning this priority should force the most limited resource to be exercised first. For example, mode-categories that have intertheater airfields as the first preferred mode should have the higher priority within the class of supply. By the same logic, POL should be moved by pipe before rail and rail before highway.

6. Inputs to Sequence 24C are percentages which are the driving factor in distributing cargo by mode. Each of the 25 mode-categories is assigned a specific percentage. The total with category of supply should equal 100 percent. Example: percentages may appear in the first three mode-categories only. The first three percentages, which correspond to the mode-categories, would equal 100 percent.

7. Sequence 24D has multiple records which indicate the first preferred mode through the seventh preferred mode, for each of the 25 mode-categories. Once the link and path data are drawn, the above described sequences will attempt to move cargo in the manner dictated.

(c) Step 3: Note that after the second preference there are no more possibilities in the example. In this event the model will repeat the first two steps of the operation, only this time it will attempt to upgrade saturated links to fulfill remaining requirements. A link will be upgraded when an "improved capacity" is specified in Field 8 of sequence 20. If the upgrade option is used, the manhour cost (Field 9) is added to the construction workload of the time period in which all subsequent time periods reflect the upgraded capacity of the link.

(d) Step 4: Finally, when no improvement or further improvement is possible, the model will choose the first preferred mode and ship the unit requirements over the first path encountered for that mode, thereby exceeding the stated capacity of some link in the path. A diagnostic will be printed to inform the analyst that this condition has occurred so that on a subsequent simulation he may provide additional paths or furnish information regarding potential upgrading of links.

(4) In the course of the processes described in steps 1-4, several functions are exercised by the model. First, when a given tonnage is shipped over a path, the "remaining capacity" of each of the constituent links of the path is decreased by the amount of tonnage shipped. Secondly, the tonnage is transformed into a workload depending on the category of supply shipped, the mode of a link, the originating region on the link, and the position in the sequence of links for the utilized path. Third, the amount of tonnage shipped decreases the requirement of the region that is being supplied and increases the requirement of the origin region of the first link in the path used. The increase is not performed when the origin region coincides with the supplied region, which may be the case when the supplied region is supplied through a port in the region.

(5) Regions are selected in the process starting with the most forward region in the first sector and moving to the most rear, then beginning at the most forward region of the second sector and again moving to the most rear. After all regions of the theater have been considered, the process will be repeated unless all requirements have been met. It is possible that all requirements may not be met for several iterations of the transportation process since a region in sector 2 may be passing its requirements to a region in sector 1. It is up to the planner to avoid a loop in which region A supports region B, which in turn supports A, or, a more subtle loop in which A supports B which supports C which supports A.

d. Computation of Workloads

(1) One of the functions of the Transportation Model is to transform tons into the proper workloads they generate. Table H-1 lists the workloads that are generated by FASTALS.

(2) Workloads 9 and 18 require a computation of STON-hours; the formula used is:

$$STON-hours\,per\,day = \frac{6DT}{5RL}$$

where D = round trip distance of link in miles
T = STONs per day hauled on link, and
RL = the rate, in miles per hour, which is applied to links having origin in logical region L

This formula is considered to be a good approximation to the standard computation of ton-hours. The basis for the formula is the addition of 2 hours (1 hour loading, 1 hour unloading) per 10-hour trip to the trip time. Thus, 10 hours of actual hauling time generate 12 hours of work.

(3) Workloads 21, 23, 27, and 41-47 are all computed by the same logic. The computation is initiated by setting the value of the workloads in each region and time period to "tons consumed."

(4) Workloads 2 and 6 are computed simply by aggregating tonnage through port and airfield links. Whenever tons pass through intertheater port links (mode 4 or 5), workloads 9 and 18 are also computed to reflect local haul requirements.

e. Unit Routing. In addition to movement of resupply tonnage, the Transportation Model also determines unit deployment routes using a special routine. The procedure applied to each unit that is required in a given sector at a given time period follows.

(1) Unit equipment transportation is handled by a different process than that which handles resupply tonnage. The reason for this is that there are no stocks from which units can be drawn when a requirement for an additional unit is established by the model. The additional unit must be brought into the theater through a port and ultimately to its designated region of employment.

(2) Unit equipment transportation routines use the same network as used by the resupply routines. Paths to be used for unit routing are excluded from consideration in the resupply routine by having a mode designation of zero. Paths which are to be candidates for unit routing are explicitly given by separate instructions. Additional information required by the algorithm is also supplied via this input. This information consists of the number of days required to traverse each candidate path and the order of preference of paths to be used.

(3) Unit routing receives priority over all resupply shipments. In other words, all units are routed to their final destinations and link capacities are appropriately decremented before the resupply transportation algorithm is initiated in the model.

(4) Before proceeding with a description of the unit routing algorithm, the planner is cautioned with respect to several of its characteristics. The procedure used to select the path of arrival (which implies mode of arrival) of units, although seemingly dynamic, is deterministic in that the final results are governed by the input. There is no attempt in the procedure at any optimal utilization of the network, minimization of distance, or time, etc. The procedure merely seeks a feasible solution.

(5) The driving input is an array that gives the number of additional units of a given type required to be employed in each sector of the theater for each time period. Each cell of the array receives individual treatment with respect to routing, but no attempt is made to split cells. To clarify, three units of a given type having a deployment weight W are handled in the same way as one unit having a weight of 3W.

(6) The algorithm to be described is the procedure for determining the route that is to be used for each group of units in a given sector for a given period.

(a) Step 1: Determine the most forward physical region within the logical region to which the given type of unit is assigned; do so as a function of sector and time period.

(b) Step 2: Consider each candidate path for the destination region determined in Step 1, in the order of preference given by input instructions. Choose the first path that satisfies the following criteria:

1. All links in path are available for entire transit time.

2. Employment time period minus number of days of transit does not result in a "pre-D-day time."

3. No link in path is saturated.

(c) Step 3: If no candidate path satisfies step 6, then assess the shortcomings of each path using the following scheme:

If 1. is not met then assign a value of 99 to given paths; if (2.) is not met, then add 50 to the value associated with a given path; if (3.) is not met, then add a one for each saturated link. Choose the path that has the lowest resulting number after the above assessment is made for all candidate paths. If 99 is the lowest value, then the implication is that there is no feasible route for the unit. The choice of the numbers reflects the degree of undesirability of using a given path.

(d) Step 4: Having determined a path for routing the unit(s), decrement the remaining capacity of each link in the chosen path during the time period preceding the time period of employment. Time period 2 (the initial time period of simulation) is used when the time period of employment

is time period two. The amount of reduction for each link is the unit's deployment weight for the first link of the path (on the assumption that the first link is a port), and the unit's nonmobile equipment weight for other links in the path. The routed tonnage depends on the prepositioned equipment that is specified for each given destination region. If prepositioned equipment exists at a given destination equal to or greater than the unit's deployment tonnage there is no burden assessed. On the other hand, if there is not enough prepositioned equipment to match the unit's weight, then port links are decremented by the deficit of tons and nonport links are decremented by a fraction of the unit's nonmobile equipment weight.

(e) Step 5: Population subset 13 is increased during the unit's movement through the theater.

(f) Step 6: The final consideration with respect to unit equipment is the assessment of the transportation workloads to which unit equipment contributes.

APPENDIX I

REPAIR PARTS ANALYSIS SPREADSHEET

1-1. GENERAL. The repair parts spreadsheet closely parallels the HET spreadsheet discussed in Appendix F.

a. The significant difference occurs at item 24, parts (org, DS, GS, depot) where weights of the parts that require retrograde are inserted.

b. The parts weight was determined by AMSAA and can be found on page E-10 in Appendix E. AMSAA used live fire assessments (SPARC) to predict the component failures due to combat loss. An explanation of SPARC is found on page 4 of the Glossary.

c. AMSAA also provided parts weights for noncombat losses were based on reliability, availability, and maintainability statistics derived from data gathered at the National Training Center.

d. The number of maintenance actions that generated parts retrograde requirements were taken from the CEM Logistics Report in 4-day increments found in Appendix D.

e. As in the HET analysis spreadsheet, a FORTRAN program managed the integration of the data and tabulation of the results by vehicle type over time.

I-2. EXAMPLE. Annex I provides a copy of the repair parts spreadsheet with sample numbers inserted in the Combat Loss Data line. Annex II provides the cell formulas for the example in Annex I.

ANNEX I TO APPENDIX I

REPAIR PARTS SPREADSHEET

MAINTENANCE DISTRIBUTION		COMBAT LOSSES TEMP	COMBAT LOSSES PERM	NON-COMBAT LOSSES TEMP	NON-COMBAT LOSSES PERM	
1. Abandoned			0%		0%	
2. K-Kill			80%			
3. Battlefield Repair		18%		20%		
4. Repair at Maint CP		59%		39%		
5. CP Transfer to ORG		23%	3%	20%	20%	
6. CP Evacution to DS		1%	2%	1%	1%	
7. CP Evacution to GS		0%	0%	0%	0%	
8. CP EVAC to Depot		0%	0%	0%	0%	
9. CP to Salvage			15%		79%	
TOTAL		100%	100%	100%	100%	
10. ORG Repair		78%		97%		
11. Org EVAC to DS		22%	0%	3%	3%	
12. ORG to Salvage			100%		97%	
TOTAL		100%	100%	100%	100%	
13. DS Repair		100%		25%		
14. DS EVAC to Backup DS		0%	0%	0%	0%	
15. DS Evacution to GS		0%	0%	75%	75%	
16. DS EVAC to Depot		0%	0%	0%	0%	
17. DS to Salvage			100%		25%	
TOTAL		100%	100%	100%	100%	
18. GS Repair		100%		100%		
19. GS EVAC to Depot		0%	0%	0%	0%	
20. GS to Salvage			100%		100%	
TOTAL		100%	100%	100%	100%	
21. Depot Repair		100%		100%		
22. Depot to Port		0%	0%	0%	0%	
23. Depot to Salvage			100%		100%	
24. PARTS (ORG, DS, GS, Depot)-SPARC			75	415	60	1350
" -RAM			10	30	5	740
COMBAT LOSS DATA	55	449	106	134	8	697

MAINTENANCE EVENTS	COMBAT LOSSES TEMP	COMBAT LOSSES PERM	NON-COMBAT LOSSES TEMP	NON-COMBAT LOSSES PERM	
1. Abandoned	0.0	0.0	0.0	0.0	0.0
2. K-Kill	0.0	84.8	0.0	0.0	84.8
3. Battlefield Repair	80.8	0.0	26.8	0.0	107.6
4. Repair at Maint CP	264.9	0.0	79.1	0.0	344.0
5. CP Transfer to ORG	101.0	2.7	27.3	1.6	132.6
6. CP Evacution to DS	2.2	2.6	0.8	0.0	5.7
7. CP Evacution to GS					
8. CP EVAC to Depot					
9. CP to Salvage		15.9		6.3	22.2
TOTAL	449.0	106.0	134.0	8.0	697.0
10. ORG Repair	78.8		26.6		105.4
11. Org EVAC to DS	22.2	0.0	0.8	0.0	23.1
12. ORG to Salvage		2.7		1.6	4.2
TOTAL	101.0	2.7	27.3	1.6	132.6
13. DS Repair	24.5		0.4		24.9
14. DS EVAC to Backup DS					
15. DS Evacution to GS	0.0	0.0	1.2	0.1	1.3
16. DS EVAC to Depot					
17. DS to Salvage		2.6		0.0	2.7
TOTAL	24.5	2.6	1.6	0.1	28.8
18. GS Repair	0.0		1.2		1.2
19. GS EVAC to Depot	0.0	0.0	0.0	0.0	0.0
20. GS to Salvage		0.0		0.1	0.1
TOTAL	0.0	0.0	1.2	0.1	1.3
21. Depot Repair	0.0		0.0		0.0
22. Depot to Port					0.0
23. Depot to Salvage		0.0		0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0

Parts Shipped per Maintenance Event	SPARC		RAM	
Org Parts Weight	75		10	
DS Weight	415		30	
GS Weight	60		5	
Depot Weight	1350	1900	740	785

Parts Shipped per Maintenance Event

	To Org	To DS	To GS	To Depot	TOTAL
1. Repair at Maint CP-SPARC	19868	109938	15895	357628	503329
2. " -RAM	791	2372	395	58504	62062
3. CP to Salvage-SPARC	0	0	0	0	0
4. " -RAM	0	0	0	0	0
5. ORG Repair-SPARC	0	32702	4728	106379	143809
6. " -RAM	0	797	133	19651	20580
7. Org to Salvage-SPARC	0	2200	318	7155	9673
8. " -RAM	0	95	16	2343	2454
9. DS Repair-SPARC	0	0	1468	33035	34503
10. -RAM	0	0	2	293	295
11. DS to Salvage-SPARC	0	0	318	7155	7473
12. " -RAM	0	0	0	36	36
13. GS Repair-SPARC	0	0	0	8417	8417
14. " -RAM	0	0	0	210	210
15. GS to Salvage-SPARC	0	0	0	0	0
16. " -RAM	0	0	0	108	108

	LR1	LR2	LR3-4	UNIT
TONNAGE FROM CP TO ORG				2.58
CP TO DS	14.04			14.04
CP TO GS	2.04			2.04
CP TO DEPOT	52.02			52.02
ORG TO DS	4.47			4.47
ORG TO GS	0.65			0.65
ORG TO DEPOT	16.94			16.94
DS TO GS	0.22			
DS TO DEPOT	5.06			
GS TO DEPOT			1.09	
TOTAL	95.44		1.09	92.74
TOTAL TONNAGE	189.3			

TRANSPORTATION TONNAGE		TOE
--FROM LR1 TO DSSA IN LR1	90.16	718
--FROM DSSA IN LR1 TO CORPS	2.91	728
--FROM DSSA IN LR1 TO DEPOT	24.02	72[illegible]
--FROM GS TO DEPOT	1.09	72[illegible]

ANNEX II TO APPENDIX I

CELL FORMULAS

```
C1: 'ETRANS REPAIR PARTS ANALYSIS SPREADSHEET
A3: 'MAINTENANCE DISTRIBUTION
D3: "     COMBAT LOSSES
F3: "  NON-COMBAT LOSSES
A4: '-----------------------
D4: "TEMP
E4: "PERM
F4: "TEMP
G4: "PERM
A5: '1.  Abandoned
E5: (PO) 0
G5: (PO) 0
A6: '2.  K-Kill
E6: (PO) 0.3
A7: '3.  Battlefield Repair
D7: (PO) 0.18
F7: (PO) 0.2
A8: '4.  Repair at Maint CP
D8: (PO) 0.59
F8: (PO) 0.59
A9: '5.  CP Transfer to ORG
D9: (PO) 0.18*1.25
E9: (PO) 0.02*1.25
F9: (PO) 0.2*1.02
G9: (PO) 0.2*1.02
A10: '6.  CP Evacution to DS
D10: (PO) 1-D7-D8-D9
E10: (PO) 1-E5-E6-E9-E13
F10: (PO) 1-F7-F8-F9
G10: (PO) 1-G5-G9-G13
A11: '7.  CP Evacution to GS
D11: (PO) 0
E11: (PO) 0
F11: (PO) 0
G11: (PO) 0
A12: '8.  CP EVAC to Depot
D12: (PO) 0
E12: (PO) 0
F12: (PO) 0
G12: (PO) 0
A13: '9.  CP to Salvage
E13: (PO) 0.15
G13: (PO) 0.79
B14: 'TOTAL
D14: (PO) @SUM(D5..D13)
E14: (PO) @SUM(E5..E13)
F14: (PO) @SUM(F5..F13)
G14: (PO) @SUM(G5..G13)
A16: '10. ORG Repair
D16: (PO) 0.78
F16: (PO) +F9/(F9+F10)
A17: '11. [illegible] EVAC to [illegible]
[illegible]
[illegible]
```

```
G17: (PO) 0.03
A18: '12. ORG to Salvage
E18: (PO) 1
G18: (PO) 0.97
B19: 'TOTAL
D19: (PO) @SUM(D16..D18)
E19: (PO) @SUM(E16..E18)
F19: (PO) @SUM(F16..F18)
G19: (PO) @SUM(G16..G18)
A21: '13. DS Repair
D21: (PO) 1
F21: (PO) 0.25
A22: '14. DS EVAC to Backup DS
D22: (PO) 0
E22: (PO) 0
F22: (PO) 0
G22: (PO) 0
A23: '15. DS Evacution to GS
D23: (PO) 0
E23: (PO) 0
F23: (PO) 0.75
G23: (PO) 0.75
A24: '16. DS EVAC to Depot
D24: (PO) 0
E24: (PO) 0
F24: (PO) 0
G24: (PO) 0
A25: '17. DS to Salvage
E25: (PO) 1
G25: (PO) 0.25
B26: 'TOTAL
D26: (PO) @SUM(D21..D25)
E26: (PO) @SUM(E21..E25)
F26: (PO) @SUM(F21..F25)
G26: (PO) @SUM(G21..G25)
A28: '18. GS Repair
D28: (PO) 1
F28: (PO) 1
A29: '19. GS EVAC to Depot
D29: (PO) 0
E29: (PO) 0
F29: (PO) 0
G29: (PO) 0
A30: '20. GS to Salvage
E30: (PO) 1
G30: (PO) 1
B31: (PO) 'TOTAL
D31: (PO) @SUM(D28..D30)
E31: (PO) @SUM(E28..E30)
F31: (PO) @SUM(F28..F30)
G31: (PO) @SUM(G28..G30)
A32: '21. Depot Repair
```

```
D33: (PO) 1
F33: (PO) 1
A34: '22. Depot to Port
D34: (PO) 0
E34: (PO) 0
F34: (PO) 0
G34: (PO) 0
A35: '23. Depot to Salvage
E35: (PO) 1
G35: (PO) 1
A37: '24. PARTS (ORG, DS, GS, Depot)-SPARC
E37: (FO) 75
F37: (FO) 415
G37: (FO) 60
H37: (FO) 1350
B38: ""
D38: "-RAM
E38: (FO) 10
F38: (FO) 30
G38: (FO) 5
H38: (FO) 740
A39: '___________________________________________
A40: (FO) 'COMBAT LOSS DATA
C40: (FO) 55
D40: (FO) 449
E40: (FO) 106
F40: (FO) 134
G40: (FO) 8
H40: (FO) @SUM(D40..G40)
A41: '-----------------------------------------
A42: 'MAINTENANCE EVENTS
D42: "     COMBAT LOSSES
F42: "  NON-COMBAT LOSSES
A43: '-----------------
D43: "TEMP
E43: "PERM
F43: "TEMP
G43: "PERM
A44: '1.  Abandoned
D44: (F1) +D40*D5
E44: (F1) +E40*E5
F44: (F1) +F40*F5
G44: (F1) +G40*G5
H44: (F1) @SUM(D44..G44)
A45: '2.  K-Kill
D45: (F1) +D40*D6
E45: (F1) +E40*E6
F45: (F1) +F40*F6
G45: (F1) +G40*G6
H45: (F1) @SUM(D45..G45)
```

```
A46: '3.  Battlefield Repair
D46: (F1) +D40*D7
E46: (F1) +E40*E7
F46: (F1) +F40*F7
G46: (F1) +G40*G7
H46: (F1) @SUM(D46..G46)
A47: '4.  Repair at Maint CP
D47: (F1) +D40*D8
E47: (F1) +E40*E8
F47: (F1) +F40*F8
G47: (F1) +G40*G8
H47: (F1) @SUM(D47..G47)
A48: '5.  CP Transfer to ORG
D48: (F1) +D40*D9
E48: (F1) +E40*E9
F48: (F1) +F40*F9
G48: (F1) +G40*G9
H48: (F1) @SUM(D48..G48)
A49: '6.  CP Evacution to DS
D49: (F1) +D40*D10
E49: (F1) +E40*E10
F49: (F1) +F40*F10
G49: (F1) +G40*G10
H49: (F1) @SUM(D49..G49)
A50: '7.  CP Evacution to GS
A51: '8.  CP EVAC to Depot
A52: '9.  CP to Salvage
E52: (F1) +E40*E13
G52: (F1) +G40*G13
H52: (F1) @SUM(D52..G52)
B53: 'TOTAL
D53: (F1) @SUM(D44..D52)
E53: (F1) @SUM(E44..E52)
F53: (F1) @SUM(F44..F52)
G53: (F1) @SUM(G44..G52)
H53: (F1) @SUM(H44..H52)
A55: '10. ORG Repair
D55: (F1) +D48*D16
F55: (F1) +F48*F16
H55: (F1) @SUM(D55..G55)
A56: '11. Org EVAC to DS
D56: (F1) +D48*D17
E56: (F1) +E48*E17
F56: (F1) +F48*F17
G56: (F1) +G48*G17
H56: (F1) @SUM(D56..G56)
A57: '12. ORG to Salvage
F57: (F1) +F48*F18
[illegible]
```

```
H57: (F1) @SUM(D57..G57)
B58: 'TOTAL
D58: (F1) @SUM(D55..D57)
E58: (F1) @SUM(E55..E57)
F58: (F1) @SUM(F55..F57)
G58: (F1) @SUM(G55..G57)
H58: (F1) @SUM(H55..H57)
A60: '13. DS Repair
D60: (F1) (D56+D49)*D21
F60: (F1) (F56+F49)*F21
H60: (F1) @SUM(D60..G60)
A61: '14. DS EVAC to Backup DS
A62: '15. DS Evacution to GS
D62: (F1) (D56+D49)*D23
E62: (F1) (E56+E49)*E23
F62: (F1) (F56+F49)*F23
G62: (F1) (G56+G49)*G23
H62: (F1) @SUM(D62..G62)
A63: '16. DS EVAC to Depot
A64: '17. DS to Salvage
E64: (F1) (E56+E49)*E25
G64: (F1) (G56+G49)*G25
H64: (F1) @SUM(D64..G64)
B65: 'TOTAL
D65: (F1) @SUM(D60..D64)
E65: (F1) @SUM(E60..E64)
F65: (F1) @SUM(F60..F64)
G65: (F1) @SUM(G60..G64)
H65: (F1) @SUM(H60..H64)
A67: '18. GS Repair
D67: (F1) +D62*D28
F67: (F1) +F62*F28
H67: (F1) @SUM(D67..G67)
A68: '19. GS EVAC to Depot
D68: (F1) +D63*D29
E68: (F1) +E63*E29
F68: (F1) +F63*F29
G68: (F1) +G63*G29
H68: (F1) @SUM(D68..G68)
A69: '20. GS to Salvage
E69: (F1) +E62*E30
G69: (F1) +G62*G30
H69: (F1) @SUM(D69..G69)
B70: (P0) 'TOTAL
D70: (F1) @SUM(D67..D69)
E70: (F1) @SUM(E67..E69)
F70: (F1) @SUM(F67..F69)
G70: (F1) @SUM(G67..G69)
H70: (F1) @SUM(H67..H69)
A72: '21. Depot Repair
D72: (F1) +D68*D33
F72: (F1) +F68*F33
H72: (F1) @SUM(D72..G72)
A73: '22. Depot to Port
H73: (F1) @SUM(D73..G73)
A74: '23. Depot to Salvage
```

```
E74: (F1) +E68*E35
G74: (F1) +G68*G35
H74: (F1) @SUM(D74..G74)
B75: 'TOTAL
D75: (F1) @SUM(D72..D74)
E75: (F1) @SUM(E72..E74)
F75: (F1) @SUM(F72..F74)
G75: (F1) @SUM(G72..G74)
H75: (F1) @SUM(H72..H74)
A77: 'Parts Shipped per Maintenance Event
E77: (F0) "SPARC
G77: (F0) "RAM
B78: 'Org Parts Weight
E78: (F0) +E37
G78: (F0) +E38
B79: 'DS Weight
E79: (F0) +F37
G79: (F0) +F38
B80: 'GS Weight
E80: (F0) +G37
G80: (F0) +G38
B81: 'Depot Weight
E81: (F0) +H37
F81: (F0) @SUM(E78..E81)
G81: (F0) +H38
H81: (F0) @SUM(G78..G81)
A82: '----------------------------------------
A83: 'Parts Shipped per Maintenance Event
A84: "----------------------------------
D85: (F0) "To Org
E85: (F0) "To DS
F85: (F0) "To GS
G85: (F0) "To Depot
H85: "TOTAL
A86: '1. Repair at Maint CP-SPARC
D86: (F0) +D47*E37
E86: (F0) +D47*F37
F86: (F0) +D47*G37
G86: (F0) +D47*H37
H86: (F0) @SUM(D86..G86)
A87: '2.
B87: '"
C87: "-RAM
D87: (F0) +F47*E38
E87: (F0) +F47*F38
F87: (F0) +F47*G38
G87: (F0) +F47*H38
H87: (F0) @SUM(D87..G87)
A88: '3. CP to Salvage-SPARC
D88: (F0) 0
E88: (F0) 0
F88: (F0) 0
G88: (F0) 0
H88: (F0) @SUM(D88..G88)
A89: '4.          "          -RAM
D89: (F0) 0
```

```
E89: (F0) 0
F89: (F0) 0
G89: (F0) 0
H89: (F0) @SUM(D89..G89)
A91: '5. ORG Repair-SPARC
D91: (F0) 0
E91: (F0) +D55*F37
F91: (F0) +D55*G37
G91: (F0) +D55*H37
H91: (F0) @SUM(D91..G91)
A92: '6.        "
B92: '       -RAM
D92: (F0) 0
E92: (F0) +F55*F38
F92: (F0) +F55*G38
G92: (F0) +F55*H38
H92: (F0) @SUM(D92..G92)
A93: '7. Org to Salvage-SPARC
D93: (F0) 0
E93: (F0) 2*E57*F37
F93: (F0) 2*E57*G37
G93: (F0) 2*E57*H37
H93: (F0) @SUM(D93..G93)
A94: '8.          "          -RAM
D94: (F0) 0
E94: (F0) 2*G57*F38
F94: (F0) 2*G57*G38
G94: (F0) 2*G57*H38
H94: (F0) @SUM(D94..G94)
A96: '9. DS Repair-SPARC
D96: (F0) 0
E96: (F0) 0
F96: (F0) +D60*G37
G96: (F0) +D60*H37
H96: (F0) @SUM(D96..G96)
A97: '10.       "
B97: '      -RAM
D97: (F0) 0
E97: (F0) 0
F97: (F0) +F60*G38
G97: (F0) +F60*H38
H97: (F0) @SUM(D97..G97)
A98: '11. DS to Salvage-SPARC
D98: (F0) 0
E98: (F0) 0
F98: (F0) 2*E64*G37
G98: (F0) 2*F64*H37
H98: (F0) @SUM(D98..G98)
A99: '12.          "          -RAM
D99: (F0) [illegible]
[illegible]
F99: (F0) [illegible]
[illegible]
[illegible]
[illegible]
```

```
E101: (F0) 0
F101: (F0) 0
G101: (F0) +D65*H47
H101: (F0) @SUM(D101..G101)
A102: '14.      "
B102: '       -RAM
D102: (F0) 0
E102: (F0) 0
F102: (F0) 0
G102: (F0) +F65*H48
H102: (F0) @SUM(D102..G102)
A103: '15. GS to Salvage-SPARC
D103: (F0) 0
E103: (F0) 0
F103: (F0) 0
G103: (F0) 2*E69*H37
H103: (F0) @SUM(D103..G103)
A104: '16.          "          -RAM
D104: (F0) 0
E104: (F0) 0
F104: (F0) 0
G104: (F0) 2*G69*H38
H104: (F0) @SUM(D104..G104)
D107: (F0) "LR1
E107: (F0) "LR2
F107: (F0) "LR3-4
G107: (F0) "UNIT
A109: 'TONNAGE FROM CP TO ORG
G109: (F2) (D86+D87)/2000/4
A110: '                   CP TO DS
D110: (F2) (E86+E87)/2000/4
G110: (F2) (E86+E87)/2000/4
A111: '                   CP TO GS
D111: (F2) (F86+F87)/2000/4
G111: (F2) (F86+F87)/2000/4
A112: '                   CP TO DEPOT
D112: (F2) (G86+G87)/2000/4
G112: (F2) (G86+G87)/2000/4
A113: '                   ORG TO DS
D113: (F2) @SUM(E91..E94)/2000/4
G113: (F2) @SUM(E91..E94)/2000/4
A114: '                   ORG TO GS
D114: (F2) @SUM(F91..F94)/2000/4
G114: (F2) @SUM(F91..F94)/2000/4
A115: '                   ORG TO DEPOT
D115: (F2) @SUM(G91..G94)/2000/4
G115: (F2) @SUM(G91..G94)/2000/4
A116: '                   DS TO GS
D116: (F2) @SUM(F96..E99)/2000/4
A117: '                   DS TO DEPOT
D117: (F2) @SUM(G96..G99)/2000/4
A118: '                   GS TO DEPOT
F118: (F2) @SUM(G101..G104)/2000/4
A120: 'TOTAL
D120: (F2) @SUM(D109..D118)
E120: (F2) @SUM(E109..E118)
```

```
G120: (F2) @SUM(G109..G118)
A122: 'TOTAL TONNAGE
D122: (F1) @SUM(D120..G120)
A124: 'TRANSPORTATION TONNAGE
G124: (P0) 'TOE
A125: '--FROM LR1 TO DSSA IN LR1
E125: (F2) @SUM(D110..D115)
G125: (F0) 718
A126: '--FROM DSSA IN LR1 TO CORPS
E126: (F2) +D111+D114+D116
G126: (F0) 728
A127: '--FROM DSSA IN LR1 TO DEPOT
E127: (F2) +D112+D115+D117
G127: (F0) 727
A128: '--FROM GS TO DEPOT
E128: (F2) +F118
G128: (F0) 727
```

APPENDIX J

SPONSOR'S COMMENTS

DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF FOR LOGISTICS
WASHINGTON, DC 20310-0500

DALO-PLP

9 DEC 1991

MEMORANDUM FOR DIRECTOR, U.S. ARMY CONCEPTS ANALYSIS AGENCY,
ATTN: CSCA-FSL, 8120 WOODMONT AVE, BETHESDA,
MD 20814-2797

SUBJECT: European Transportation Requirements for the Backhaul of Personnel/Cargo (ETRANS) Study

1. Reference memorandum, CSCA-FSL, 30 Sep 91, SAB.

2. The study is clearly exceptional work and accomplished our stated objectives. However, the world has changed during the last 18 months. Some changes reflected in the Army include: new heavy equipment transporter doctrine and organization, changed scenarios, new lines of communications distances, and downsizing.

3. Recommend this study be closed out and an update be postponed until the TAA 2001 design force is available during the summer of 1992. The Army can then draft the POM addressing this force during Dec 93-Feb 94. This schedule would allow us the necessary time to change the force based on your findings.

4. Our Integration Branch would sponsor the updated study.

5. The ODCSLOG Study Coordinator is Mr. Redfern, DALO-PLP, (703)614-9735.

FOR THE DEPUTY CHIEF OF STAFF FOR LOGISTICS:

JERE H. AKIN
Major General, GS
Director of Plans
and Operations

APPENDIX K

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GLOSSARY

1. ABBREVIATIONS, ACRONYMS, AND SHORT TERMS

ACR	armored cavalry regiment
AD	armored division
AFPDA	Army Force Planning Data and Assumptions (draft 1990)
ALOC	air line(s) of communication
AMSAA	Army Materiel Systems Analysis Agency
APC	armored personnel carrier
APOD	aerial port of debarkation
APOE	aerial of embarkation
AR	allocation rule
AVIM	aviation intermediate maintenance
CAA	US Army Concepts Analysis Agency
CASCOM	US Army Combined Arms Support Command (formerly LOGCEN)
CEM	Concepts Evaluation Model
CFE	Conventional Forces in Europe
CINCUSAREUR	Commander in Chief, United States Army, Europe
co, cos	company, companies
COMMZ	communications zone
COMPASS	Computerized Movement Planning and Status System
CONUS	continental United States
COSCOM	Corps Support Command
CP	collection point
CS	combat support
CSS	combat service support
CUCV	commercial utility cargo vehicle
CY	calendar year

CZ	combat zone
CTA	common table of allowances
DA	Department of the Army
DCSLOG	Deputy Chief of Staff for Logistics
DCSOPS	Deputy Chief of Staff for Operations
D-day	actual or planned first day of hostilities
DISCOM	Division Support Command
div	division
DNBI	disease and nonbattle injuries
DOD	Department of Defense
DS	direct support
DSA	division support area
EPW	enemy prisoners of war
EVAC	evacuation
FASTALS	Force Analysis Simulation of Theater Administrative and Logistic Support (model)
FEBA	forward edge of the battle area
FM	field manual
GRREG	graves registration
GS	general support
HET	heavy equipment transporter
HMMWV	high mobility multipurpose wheeled vehicle
HN	host nation
HND	host nation direct
HNI	host nation indirect
HNS	host nation support
HQDA	Headquarters, Department of the Army

JSPDA	Joint Strategic Planning Document Analysis
KCMIA	killed, captured, and missing in action
KIA	killed in action
K-kill	catastrophic kill
km	kilometer(s)
LOC	lines of communication
LR	logical region
MACRIT	Manpower Requirement Criteria
MARC	Manpower Requirements Criteria
MHE	materials handling equipment
MIA	missing in action
MOADS	Maneuver Oriented Ammunition Distribution System
MPH	miles per hour
MPS	Military Postal Service
MRSA	US Army Materiel Readiness Support Activity
MSR	main supply route
MTMC	Military Traffic Management Command
NATO	North Atlantic Treaty Organization
NBC	nuclear, biological, and chemical
NEO	noncombatant evacuation order
NMWT	nonmobile weight
NORTHAG	Northern Army Group, Central Region
ODCSLOG	Office of the Deputy Chief of Staff, Logistics
ORD	Ordnance
Org	organization
PAX	passenger(s)
PFASS	Programmed Force Alternative Scenario Study

PFCAE	Programmed Force Capabilities Assessment Europe
PFM	Patient Flow Model
POL	petroleum, oils, and lubricants
POM	Program Objective Memorandum
POMCUS	prepositioned materiel configured to unit sets
POV	privately owned vehicle
POW	prisoner(s) of war
PWRMS	prepositioned war reserve materiel stock
QM	quartermaster
RAM	reliability, availability, and maintainability
RCZ	rear combat zone
RETRO	Wartime Retrograde of Damaged Materiel from a Theater of Operations (study)
RETRO II	Retrograde Transportation II (study)
SP	self-propelled
SPOE	seaport of embarkation
SRC	standard requirement code
STON	short ton(s)
TAA	Total Army Analysis
TAACOM	theater Army area command
TDA	table(s) of distribution and allowances
TOE	tables(s) of organization and equipment
TP	time period
TPFDL	Time-Phased Force Deployment List
TR	theater reserve
TRADOC	US Army Training and Doctrine Command
TTP	trailer transfer point
UMC	unit movement code

UMCP	unit maintenance collection point
USAFE	United States Air Forces Europe
USAMC	US Army Materiel Command
USAREUR	United States Army Europe
USEUCOM	US European Command
WIA	wounded in action
Wkld	Workload

2. MODELS, SIMULATIONS, AND ROUTINES

CEM	Concepts Evaluation Model - A low resolution, computerized, theater level combat model.
FASTALS	Force Analysis Simulation of Theater Administrative and Logistic Support Model - a model which computes administrative and logistical workloads of a combat force and adds support units to the theater force to accomplish the support requirements of both the combat and support forces.
PFM	Patient Flow Model - a deterministic model that uses wounded in action and disease and nonbattle injury rates, population, and evacuation policy to determine the number of hospital patients, return to duty personnel, evacuation requirements, and the numbers of those who died in hospitals.
SPARC	Sustainability Predictions for Army Spare Components Requirements for Combat - a sequence of steps starting with scenario definition in which the Ballistics Research Laboratory conducts live fire damage assessment of shot lines using threat-like ammunition to predict the vulnerabilities of vehicles and the requirements for vehicle repair in terms of parts, labor, and time.

3. DEFINITIONS

backhaul
A specific term referring to that portion of a truck mission used to transport personnel or equipment away from the battle area, usually a second or "opportunity" lift after it completes the primary lift normally toward the battle area.

combat loss
A vehicle identified in the CEM Logistics Report as either a temporary (repairable) or permanent (salvaged) loss.

line haul

Line hauls have a long running time compared to loading and unloading time. They normally involve one trip or portion of one trip per operating shift. They are evaluated on the basis of time consumed, distance traveled, and tonnage hauled during the operational period. Current planning factors from FM 101-10-1/2 are one trip per 10-hour operating shift, traveling a distance of 90 miles one way.

local haul

Local hauls have a short running time compared to loading and unloading time. They normally involve a number of trips per day. Current planning factors from Technical Manual (TM) 101-10-1/2 are two trips per 10-hour operating shift, traveling a distance of 20 miles one way.

noncombat losses

A vehicle identified on the CEM Logistics Report as either a temporary (repairable) or permanent (salvaged) loss as a result of reliability, maintainability, or maintainability failure.

nonmobile weight

TOE items not transportable by a single sortie of the moving unit's wheeled vehicles.

retrograde

A general term that encompasses both operational and logistics movement away from a forward area toward the rear; e.g., a movement from the corps area to the COMMZ. ETRANS is concerned solely with retrograde for logistics (not operational) purposes.

ton-hour

A unit of work measure equal to transporting a short ton of cargo for one hour at a given rate.

CAA (UNITED STATES ARMY CONCEPTS ANALYSIS AGENCY)	**EUROPEAN TRANSPORTATION REQUIREMENTS FOR THE BACKHAUL OF PERSONNEL/CARGO (ETRANS) STUDY**	**STUDY SUMMARY CAA-SR-91-11**

THE REASON FOR PERFORMING THE STUDY was to determine if the logistics movement of personnel/cargo away from the forward edge of the battle area (FEBA) is a significant transportation workload. If significant, how should it be incorporated into theater force structure determination.

THE STUDY SPONSOR was the Deputy Chief of Staff for Logistics (DCSLOG), Headquarters, Department of the Army (HQDA).

THE STUDY OBJECTIVE was to determine the effect of retrograde transportation requirements on the total force structure and to determine if a "retrograde transportation force structure planning factor" can be developed.

THE SCOPE OF THE STUDY was to use the results of two significantly different wartime analysis studies performed by US Army Concepts Analysis Agency (CAA). The first, Programmed Force Capabilities Analysis Europe-96 (PFCAE-96), is the traditional scenario of global conventional war with the Warsaw Pact; no chemical or nuclear warfare. The second, Program Force Alternative Scenario Study (PFASS), models the post-Conventional Forces in Europe (CFE) battlefield.

THE MAIN ASSUMPTIONS of this work were:

(1) Data from the Army Force Planning Data and Assumptions (AFPDA) are appropriate for this analysis.

(2) Host nation support will be available as bilaterally agreed.

(3) The use of transportation modes consistent with United States Army, Europe (USAREUR) theater policy is appropriate for this analysis.

(4) Retrograde (backhaul) movements begin on D-day.

THE BASIC APPROACH was to consider all retrograde (backhaul) missions and compare the results for the two scenarios. Total mission requirements were estimated, the mission requirements were analyzed from a transportation viewpoint, and transportation resources were allocated by truck type and nationality for mission execution.

THE PRINCIPAL FINDINGS of this study are:

(1) Daily passenger (PAX) for retrograde movement averaged 9,218 for PFCAE-96 and 4,507 for PFASS in addition to noncombatant evacuation operations. Daily retrograde cargo in short tons (STON) averaged 41,186 for PFCAE-96 and 16,971 for PFASS. Daily rearward movements by heavy equipment transporter (HET) of combat vehicles averaged 396 for PFCAE-96 and 222 for PFASS in addition to the commander's requirement for tactical relocation HET support.

(2) To execute the tracked vehicle maintenance evacuation mission, PFCAE-96 required between 6 and 8 heavy truck companies (24 HETs per company) available at the beginning of the war depending on the degree of risk to be assumed. PFASS required three companies. Other missions for heavy trucks are tactical relocation and aiding the relocation of maintenance units working on tracked vehicles.

(3) The net total US force structure additions required are five medium and three heavy truck companies for the PFCAE-96 scenario and two medium and two heavy truck companies for PFASS. These are minimum US additions and exclusive of force structure that can be reasonably provided by the host nation.

(4) Dislocation of the FEBA is the overwhelming influence on the need for additions to overall transportation force structure, including US force structure additions. Combat support/combat service support (CS/CSS) unit movement requirements comprise the greatest single part of the addition. The current force structuring process does not compute common-user transportation requirements for any unit moves after initial battlefield deployment. Other operational factors affecting force structure additions are the degree of peacetime preparation for war, warning time prior to movement, host nation support, and air superiority.

(5) Light trucks used for retrograde are almost exclusively in support of noncombatant evacuation order (NEO): a planning factor of .92 light truck companies per 100,000 NEO participants is reasonable for the Central Region. Host nation buses are preferred for this mission. Planning factors for medium trucks are a population constant of .83 medium truck companies per 100,000 theater population and a FEBA displacement factor of .297 medium truck companies times the average rate of FEBA displacement in kilometers per day. Heavy trucks are used in proportion to the intensity of the battle and the desires of the commander. No general planning factor could be determined for heavy trucks.

COMMENTS AND QUESTIONS may be sent to the Director, US Army Concepts Analysis Agency, ATTN: CSCA-FSL, 8120 Woodmont Avenue, Bethesda, Maryland 20814-2797

CAA	**EUROPEAN TRANSPORTATION REQUIREMENTS FOR THE BACKHAUL OF PERSONNEL/CARGO (ETRANS) STUDY**	**STUDY SUMMARY CAA-SR-91-11**

THE REASON FOR PERFORMING THE STUDY was to determine if the logistics movement of personnel/cargo away from the forward edge of the battle area (FEBA) is a significant transportation workload. If significant, how should it be incorporated into theater force structure determination.

THE STUDY SPONSOR was the Deputy Chief of Staff for Logistics (DCSLOG), Headquarters, Department of the Army (HQDA).

THE STUDY OBJECTIVE was to determine the effect of retrograde transportation requirements on the total force structure and to determine if a "retrograde transportation force structure planning factor" can be developed.

THE SCOPE OF THE STUDY was to use the results of two significantly different wartime analysis studies performed by US Army Concepts Analysis Agency (CAA). The first, Programmed Force Capabilities Analysis Europe-96 (PFCAE-96), is the traditional scenario of global conventional war with the Warsaw Pact; no chemical or nuclear warfare. The second, Program Force Alternative Scenario Study (PFASS), models the post-Conventional Forces in Europe (CFE) battlefield.

THE MAIN ASSUMPTIONS of this work were:

(1) Data from the Army Force Planning Data and Assumptions (AFPDA) are appropriate for this analysis.

(2) Host nation support will be available as bilaterally agreed.

(3) The use of transportation modes consistent with United States Army, Europe (USAREUR) theater policy is appropriate for this analysis.

(4) Retrograde (backhaul) movements begin on D-day.

THE BASIC APPROACH was to consider all retrograde (backhaul) missions and compare the results for the two scenarios. Total mission requirements were estimated, the mission requirements were analyzed from a transportation viewpoint, and transportation resources were allocated by truck type and nationality for mission execution.

THE PRINCIPAL FINDINGS of this study are:

(1) Daily passenger (PAX) for retrograde movement averaged 9,218 for PFCAE-96 and 4,507 for PFASS in addition to noncombatant evacuation operations. Daily retrograde cargo in short tons (STON) averaged 41,186 for PFCAE-96 and 16,971 for PFASS. Daily rearward movements by heavy equipment transporter (HET) of combat vehicles averaged 396 for PFCAE-96 and 222 for PFASS in addition to the commander's requirement for tactical relocation HET support.

(2) To execute the tracked vehicle maintenance evacuation mission, PFCAE-96 required between 6 and 8 heavy truck companies (24 HETs per company) available at the beginning of the war depending on the degree of risk to be assumed. PFASS required three companies. Other missions for heavy trucks are tactical relocation and aiding the relocation of maintenance units working on tracked vehicles.

(3) The net total US force structure additions required are five medium and three heavy truck companies for the PFCAE-96 scenario and two medium and two heavy truck companies for PFASS. These are minimum US additions and exclusive of force structure that can be reasonably provided by the host nation.

(4) Dislocation of the FEBA is the overwhelming influence on the need for additions to overall transportation force structure, including US force structure additions. Combat support/combat service support (CS/CSS) unit movement requirements comprise the greatest single part of the addition. The current force structuring process does not compute common-user transportation requirements for any unit moves after initial battlefield deployment. Other operational factors affecting force structure additions are the degree of peacetime preparation for war, warning time prior to movement, host nation support, and air superiority.

(5) Light trucks used for retrograde are almost exclusively in support of noncombatant evacuation order (NEO): a planning factor of .92 light truck companies per 100,000 NEO participants is reasonable for the Central Region. Host nation buses are preferred for this mission. Planning factors for medium trucks are a population constant of .83 medium truck companies per 100,000 theater population and a FEBA displacement factor of .297 medium truck companies times the average rate of FEBA displacement in kilometers per day. Heavy trucks are used in proportion to the intensity of the battle and the desires of the commander. No general planning factor could be determined for heavy trucks.

COMMENTS AND QUESTIONS may be sent to the Director, US Army Concepts Analysis Agency, ATTN: CSCA-FSL, 8120 Woodmont Avenue, Bethesda, Maryland 20814-2797.

EUROPEAN TRANSPORTATION REQUIREMENTS FOR THE BACKHAUL OF PERSONNEL/CARGO (ETRANS) STUDY	**STUDY SUMMARY CAA-SR-91-11**

THE REASON FOR PERFORMING THE STUDY was to determine if the logistics movement of personnel/cargo away from the forward edge of the battle area (FEBA) is a significant transportation workload. If significant, how should it be incorporated into theater force structure determination.

THE STUDY SPONSOR was the Deputy Chief of Staff for Logistics (DCSLOG), Headquarters, Department of the Army (HQDA).

THE STUDY OBJECTIVE was to determine the effect of retrograde transportation requirements on the total force structure and to determine if a "retrograde transportation force structure planning factor" can be developed.

THE SCOPE OF THE STUDY was to use the results of two significantly different wartime analysis studies performed by US Army Concepts Analysis Agency (CAA). The first, Programmed Force Capabilities Analysis Europe-96 (PFCAE-96), is the traditional scenario of global conventional war with the Warsaw Pact; no chemical or nuclear warfare. The second, Program Force Alternative Scenario Study (PFASS), models the post-Conventional Forces in Europe (CFE) battlefield.

THE MAIN ASSUMPTIONS of this work were:

(1) Data from the Army Force Planning Data and Assumptions (AFPDA) are appropriate for this analysis.

(2) Host nation support will be available as bilaterally agreed.

(3) The use of transportation modes consistent with United States Army, Europe (USAREUR) theater policy is appropriate for this analysis.

(4) Retrograde (backhaul) movements begin on D-day.

THE BASIC APPROACH was to consider all retrograde (backhaul) missions and compare the results for the two scenarios. Total mission requirements were estimated, the mission requirements were analyzed from a transportation viewpoint, and transportation resources were allocated by truck type and nationality for mission execution.

THE PRINCIPAL FINDINGS of this study are:

(1) Daily passenger (PAX) for retrograde movement averaged 9,218 for PFCAE-96 and 4,507 for PFASS in addition to noncombatant evacuation operations. Daily retrograde cargo in short tons (STON) averaged 41,186 for PFCAE-96 and 16,971 for PFASS. Daily rearward movements by heavy equipment transporter (HET) of combat vehicles averaged 396 for PFCAE-96 and 222 for PFASS in addition to the commander's requirement for tactical relocation HET support.

(2) To execute the tracked vehicle maintenance evacuation mission, PFCAE-96 required between 6 and 8 heavy truck companies (24 HETs per company) available at the beginning of the war depending on the degree of risk to be assumed. PFASS required three companies. Other missions for heavy trucks are tactical relocation and aiding the relocation of maintenance units working on tracked vehicles.

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(4) Dislocation of the FEBA is the overwhelming influence on the need for additions to overall transportation force structure, including US force structure additions. Combat support/combat service support (CS/CSS) unit movement requirements comprise the greatest single part of the addition. The current force structuring process does not compute common-user transportation requirements for any unit moves after initial battlefield deployment. Other operational factors affecting force structure additions are the degree of peacetime preparation for war, warning time prior to movement, host nation support, and air superiority.

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COMMENTS AND QUESTIONS may be sent to the Director, US Army Concepts Analysis Agency, ATTN: CSCA-FSL, 8120 Woodmont Avenue, Bethesda, Maryland 20814-2797